Technical and Scientific Papers

1984
MANITOBA AGRONOMISTS' CONFERENCE PROCEEDINGS

December 12 & 13, 1984

85-5553/

TECHNICAL AND SCIENTIFIC PAPERS PRESENTED AT

1984

MANITOBA AGRONOMISTS'

ANNUAL CONFERENCE

ANNUAL CONFERENCE OF MANITOBA AGRONOMISTS

Agriculture Auditorium, Faculty of Agriculture
University of Manitoba, Winnipeg, Manitoba
December 12 and 13, 1984

1984 OFFICERS

President	- G. Friesen Agriculture Canada Research Station Box 3001 Morden, Manitoba
Vice-President	- L. Sernyk Department of Plant Science University of Manitoba Winnipeg, Manitoba
Past President	- A.L.D. Martin Manitoba Agriculture 908 Norquay Building Winnipeg, Manitoba
Secretary	- S.P. Banasiak Crops Division Manitoba Agriculture 908 Norquay Building Winnipeg, Manitoba
Executive	- G. Plohman Agricultural Engineer Manitoba Agriculture Beausejour, Manitoba
	- C. Nachtigall Manitoba Agriculture 903 Norquay Building Winnipeg, Manitoba
	- J. Ewanek Manitoba Agriculture 908 Norquay Building Winnipeg, Manitoba
	- A. Kolach Manitoba Agriculture 911 Norquay Building Winnipeg, Manitoba

ARTICLES MAY NOT BE PRINTED
WITHOUT AUTHOR'S PERMISSION.

TABLE OF CONTENTS

MANITOBA AGRICULTURAL SERVICES CO-ORDINATING COMMITTEE	PAGE
CROP SCIENCE LEAD COMMITTEE	
CEREAL CROPS SUB-COMMITTEE	
The Malting Status of Argyle, Norbert and TR 212	1
The Orange Wheat Blossom Midge, its Distribution and the Damage it Caused to Wheat in Manitoba During 1984	2
OILSEEDS AND SPECIAL CROPS SUB-COMMITTEE	
Agro-Man Soybean Project	10
Safflower - A Potential Crop for Manitoba	20
Manitoba Pulse Growers' Association	25
FORAGE CROPS SUB-COMMITTEE	
Forage/Herbicide Screening Trials	30
Tolerance of Alfalfa for Seed to 2,4-DB and Bromoxynil	32
Annual Crops for Forages	36
New Manitoba Crop Insurance Forage Programs	45
PLANT DISEASES SUB-COMMITTEE	
Manitoba Head Smut of Corn	48
Diseases of Wild Rice	52
WEEDS SUB-COMMITTEE	
Herbicide/Herbicide, Herbicide/Adjuvant, and Herbicide/Insecticide Mixture	55
A Review of the Development of Selective Graminaceous Herbicides	62
Green Foxtail (Setaria viridis) Competition and Control In Russet Burbank Potatoes	65
CROP MANAGEMENT SUB-COMMITTEE	
Semi-Dwarf Wheats in the Market Place	69
Agronomic Performance of American Semi-Dwarf Varieties	73
Intensive Management of Winter Wheat on the Prairies	76
State of the Art in Zero Tillage	87
HORTICULTURE SUB-COMMITTEE	
Plasticulture Technology for Vegetable Crop Production	94
SOIL SCIENCE LEAD COMMITTEE	
The Effect of Soil Erosion on Soil Productivity: Preliminary Findings of a Two-Year Study	102
N-P Dual Banding Update	107
PEST MANAGEMENT LEAD COMMITTEE	
European Corn Borer Infestation - 1984	118
Manitoba Grasshopper Forecast - 1985	121
The 1984 Sunflower Midge	122

1985 EXECUTIVE AND COMMITTEES

EXECUTIVE

President	- E. Larter
Vice-President	- K. Walkoff
Past President	- G. Friesen
Secretary	- S. Banasiak
Executive	- A. Kolach, C. Nachtigall, J. Ewanek, G. Plohman.

MANITOBA AGRICULTURAL SERVICES CO-ORDINATING COMMITTEE

CROP SCIENCE LEAD COMMITTEE - Chairman - P. McVetty

Vice-Chairman - T.A. Sandercock

Secretary - S.P. Banasiak

SUB-COMMITTEES:

Cereal Crops	- M. Therrien (Chairman), A.B. Campbell, L. Evans, E. Senkow, D. Leisle, D. Brown, S. Kirkland, R. Roehle, G.M. Young, R. Scarth.
Oilseeds & Special Crops	- E.O. Kenaschuk (Chairman), B. Andrews, S.T. Ali-Khan, G.H. Gubbels, P. McVetty, J.R. Rogalsky, J.Y. Tsukamoto, B.R. Stefansson, D. Watson, F. Kiehn, B. Awmack, W. Dedio, C. Campbell, J. Zednai, F. Wonnick.
Corn	- E. Larter (Chairman), J. Giesbrecht, G. Bonnefoy, K. Clark, W. Migus, E. von Graevenitz, J.R. Rogalsky, C. Shaykewich, O. Beever, C. Shields, T. Davidson, A. Petkau.
Forage Crops	- R. Simons (Chairman), K.W. Clark, K. Wittenberg, D. Campbell, H. Johnson, L. Dyck, G. Breakey, B. Halstead, M. Goodwin, R. Salmon.
Crop Management	- H. Nelson (Chairman), J. Ewanek, A. Sturko, C. Jenkins, B. McCannell, G. Platford, D. Rourke, W. Turnock, K. Watson.

Horticulture	- T.A. Sandercock (Chairman), M.B. McConnell, L.M. Lenz, Dr. M. Pritchard, G. Stone, B.B. Chubey, G. Mazza, D. Jones, M. Dione, R. Kennedy, W. DeLong, C. Biescheuvel, K. Twomey, W. Siemens, H. Skinner, J. Sosiak, E. Connery, R. Paul, H.W. Thiessen.
Plant Diseases	- N.C. English (Chairman), J. Chang, R. Rimmer, R. Zimmer, R. Minogue, B. Morse, D. Abramson, D. Punter, G. Platford, R. Jackson, P. Thomas, R. Haugh, S. Haber, A. Tekauz.
Weeds	- B. Todd (Chairman), P. Chow, G. Marshall, G. Friesen, W. Duncan, M. Archambault, E. Partyka.

PEST MANAGEMENT LEAD COMMITTEE - Chairman - D.L. Smith
Secretary - A.J. Kolach

SUB-COMMITTEES:

Apiculture	- S.C. Jay (Chairman)
Fruit, Field, Vegetable Turf and Greenhouse Crops	- D.J. McCullough (Chairman)
Livestock	- T.D. Galloway (Chairman)
Public Health	- M.M. Galloway (Chairman)
Stored Products	- J.B. Van Loon (Chairman)
Shade Tree and Forestry	- K.R. Knowles (Chairman)

FOOD SCIENCE LEAD COMMITTEE - Chairman - T.J. McEwen

SOCIO-ECONOMIC LEAD COMMITTEE - Chairman -

SOIL SCIENCE LEAD COMMITTEE - Chairman - G. Racz

AGRICULTURAL ENGINEERING LEAD COMMITTEE - Chairman - O. Friesen

THE MALTING STATUS OF ARGYLE, NORBERT AND TR 212

Argyle, a blue aleurone six-row variety, was licensed in 1981 as an improved variety widely adapted throughout the prairies. Norbert was licensed in 1980 as a two-row variety with adequate disease resistance for production in the eastern prairie region. Both varieties showed good malting and brewing quality in pilot scale tests conducted prior to licensing. Following licensing the Canadian Wheat Board, in cooperation with SeCan, contracted for the production of a number of fields of both varieties in 1982 and 1983 to provide carlots for plant scale malting and brewing trials. These trials were conducted by three malting and three brewing companies.

Argyle was satisfactory and equal to Bonanza in malting performance and showed some advantage in enzyme levels. It was generally acceptable in brewing performance and beer quality. Argyle should compete with Bonanza in the domestic six-row malting market. Export demand for Canadian six-row malting barley and malt is relatively limited but Argyle should also compete favorably in this market.

The trials on Norbert showed satisfactory malting performance but some difficulties were encountered controlling high soluble protein levels. Brewing performance was fairly satisfactory but all breweries rated beer quality inferior to Klages. It is, therefore, unlikely that Norbert will be generally accepted in the malting market.

The selection TR 212, which could be considered an improved Norbert, has been approved for licensing but naming and release are being delayed until more information is available on its probable acceptance in the malting market. In pilot scale tests TR 212 showed some different and potentially beneficial quality characteristics. Malting experience is necessary to determine whether these benefits can be realized in regular commercial production.

In 1984 the Canadian Wheat Board contracted 16 fields of TR 212 for plant scale quality testing and only small quantities of pedigreed seed were produced. Only one, or possibly two, lots of the 1984 production were of suitable quality for malting and brewing trials. Specific plans for these trials have been made and results will be available next summer. A second year of quality tests on contract production from the 1985 crop is planned and a small increase of Foundation seed will be made by SeCan.

It is expected that this procedure for seed increase and quality evaluation will avoid the situation which has occurred in the past when seed supplies of new potential malting varieties were increased to high levels before their market status was established.

THE ORANGE WHEAT BLOSSOM MIDGE, ITS DISTRIBUTION AND THE DAMAGE IT CAUSED TO WHEAT IN MANITOBA DURING 1984.

Philip S. Barker

Research Station, Agriculture Canada, 195 Dafoe Road,
Winnipeg, Manitoba, R3T 2M9

ABSTRACT

Wheat heads were collected from 229 fields distributed in 26 Agricultural Representative's districts in Manitoba during August of 1984. Wheat midges or their damage were found in samples from all of the districts: from Beausejour in the east to Virden in the west from Killarney in the south, to Swan River in the north. The damage consisted of a shrivelling and bending of the seeds, or a splitting of the pericarp in seeds affected at a later stage of development. There was considerable variability in the amount of grain lost in samples from any given district: 0.0 to 25.7% grain loss was found for the samples from Swan River and a range of losses from 4.3 to 18.0% was found for The Pas. Individual samples with more than 10% loss of kernels were from Selkirk, Swan River, and The Pas. Samples with more than 4% loss came from Altona, Gladstone, Lundar, McCreary, Roblin, Selkirk, Steinbach, Swan River, Teulon, and The Pas.

Damage due to at least eight arthropod species was recorded (the orange wheat blossom midge, thrips, two species of lepidoptera larvae, and four species of mites). Similarly, high levels of black point were observed. Five kinds of damage due to other causes were also noted: one was a splitting of the pericarp of the seeds along the lateral sides of the kernels (distinct from the splitting of pericarp due to the wheat midge), the second was a collapsing of the seed (also distinct from the shrivelling caused by the wheat midge), and the third was similar to "starchy" condition, but limited to a small portion of the kernels. The fourth kind of damage was represented by pink seeds of similar color to those treated by fungicides and the fifth kind of damage was to durum wheat, in which the pericarp tended to blister at the brush end of the kernels. The second and third conditions were almost as common as midge damage in most parts of Manitoba.

INTRODUCTION

The wheat midge has existed in Canada (Ontario) since the early years of the twentieth century (Ross, 1919). It has been in Manitoba for more than 30 years, since it was reported in 1954 from Selkirk by Prof. A.V. Michener (Dept. Entomol., Univ. Manitoba). During 1955, specimens were collected at Teulon, St. Francois Xavier, Morris, St. Pierre, and Transcona (Allen 1955a).

Manitoba samples of the orange wheat blossom midge, Sitodiplosis mosellana (Gehin), were positively identified by W.F. Barnes of the Rothamstead Experimental Station, who distinguished them from a similar midge, Contarinia tritici (Kirby), which also occurs on wheat

blossoms in Europe and other parts of the world (Allen 1955b). The crops affected by the wheat midge include wheat, barley, various grasses, and oats.

The wheat midge damaged experimental plots at the University of Manitoba (Bird and Robinson, 1956) and was a widespread pest during the 1956 growing season; it was also reported from the north west corner of Minnesota and from Pembina County, North Dakota. Losses were estimated at between 10 and 30% (Anon., 1956).

During 1957, damage amounted to 6.4% near Winnipeg, 5.9% at Morris, 4.2% at Altona, 4.4% at Starbuck, 13.6% at Pigeon Lake, and 7.2% at Portage la Prairie. No midges were found at Brandon, Neepawa, or Swan River (Westdal, 1957a).

Westdal (1957b) compared the infestation levels of wheat midge found on 10 cultivars of wheat in Fort Garry, and found that the variety Frontana was the only one which did not show damage due to the midge. This was probably due to the fact that Frontana was a late blooming cultivar and could have escaped the oviposition period of the midges, though this cultivar could be affected by early frosts.

A parasite of the wheat midge, Pirene penetrans (Kirby) was identified by C.D.F. Miller and confirmed by G.F. Kerrich (Commonwealth Inst. Entomol., London). The original name of the wasp was Macroglenes penetrans Kirby, a synonym of M. oculatus Westwood (personal letter from C.D.F. Miller to W.R. Allen, 28 Nov. 1960, Ottawa).

No further work was done in Canada on the wheat midge in the years 1958 to 1982. It was not until 1983 that a sudden increase of midge populations in the north western Manitoba and north eastern Saskatchewan wheat growing regions renewed interest in this pest.

Samples of wheat heads were collected from the north eastern portion of the Manitoba wheat growing region during 1983. The damage in these samples varied from 3.3 to 21% for Swan River material, 1 to 26% for wheat heads from The Pas, 0.0 to 13% damage was found in samples from Roblin and the two samples from Dauphin had 3 and 14% damage (Barker, 1983a).

In samples from the Agriculture Canada experimental plots at Glenlea, awned wheats showed an average loss of 6.5% of kernels, wheats grown on irrigated land had 3.6% damage and wheat grown on non-irrigated land had 2.3% damage (Barker, 1983b). Some samples from the 1982 season, which had been retained, showed damage of 4.9%.

The objective of this survey was to establish the distribution of the orange wheat blossom midge during the 1984 growing season, and to estimate the severity of the damage it caused. A second objective was record other pests which might be present on wheat spikes.

MATERIALS AND METHODS

Samples of heads of wheat were collected at random from five widely separated fields in each Agricultural Representative's district, except for Swan River where 114 fields were sampled. A total of 229 fields distributed in 26 districts were sampled. Each sample consisted of ten heads of wheat which were placed in paper or in plastic bags and sent to Winnipeg for examination.

Each head of wheat was dissected under a low power dissection microscope. The numbers of midge affected seeds were counted for each head of wheat and recorded; the numbers of seeds per head were also counted for most samples. Damages due to other causes were photographed and, where possible, the arthropods causing damage were sent to the National Identification Service. A. Tekauz (Agric. Canada, Winnipeg) examined samples presumed to be diseased.

RESULTS

Damage due to several species of arthropods were found on the wheat heads examined. The larvae of the wheat head army worm, Faronta diffusa (Wlk.), ate large parts of the kernels, including the pericarp; these kernels would probably be classified as "broken kernels" during the inspection process. The larvae of another species of Lepidoptera merely made neat holes in the seeds, consumed the interior of the kernels and produced webbing; threshing of the wheat probably removes the webbing from the surface of the kernels. Some damage similar to the latter kind has been found in soft wheats in Saskatchewan during 1984 (Lloyd Harris, personal communication).

Four species of mites were found on wheat heads which came from Laurier, Teulon, and Ashern. These species were: Siteroptes avenae, S. sp. near renniformis Krantz, Tarsonemus confusus Ewing, and T. sp. near bilobatus. The two species of Tarsonemus were associated with a scarification of the surfaces of the wheat seeds; the Siteroptes spp. appeared to be associated with kernels that were scarified and not quite as well filled as other seeds on the same spikes.

Damage to wheat kernels due to thrips was recognized. Trips produced a scarification of the surfaces of the wheat kernels similar to the damage produced by Tarsonemus spp., but their presence was usually associated with small green faecal spots.

Some wheat samples showed high levels of black point, while others had a few ergot infected kernels. Some seeds from the Swan River district had small tears in the pericarps along the lateral sides of the kernels; this kind of damage was not due to the wheat midge.

Seeds with a well-developed pericarp, but empty, were found regularly and were almost as common as was midge damage; they looked like collapsed balloons.

A condition similar to "starchy" was found in kernels from many parts of Manitoba. "Starchy" has been defined as a whitening of the endosperm of wheat kernels so that they lose their normal "crystalline" appearance; two causes of "starchy" seem to be a lack of nitrogen and weathering of the seeds. The condition which is similar to "starchy" causes a whitening to only a small part of the seeds (usually less than 0.25 of a kernel) and often has a small dark spot at the center of the surface of the whitened portion.

Many samples from the Swan River district produced kernels that were pink and looked like seeds treated with a fungicide; Helminthosporium tritici-repentis was found in 13 out of 30 pink seeds examined. Samples of durum wheat contained seeds which had blisters in the pericarp at the brush end; the pericarp was separated from the endosperm.

Damage due to the wheat midge was characteristic and consisted of a shrivelling of the wheat kernels. This shrivelling was characterized by the presence of a large number of longitudinal wrinkles in the pericarp of the most highly affected seeds and the almost total absence of endosperm and germ. Badly affected seeds were often bent into a "J" shape. Seeds that were lightly affected did not show the "J" shape, or wrinkles, or very much shrivelling, but they often had a split, or tear, in the pericarp which exposed the endosperm and the embryo; they were, in fact, of almost normal size, and hence would be included with normal grain for shipment because they are not culled during dockage removal. Very lightly affected seeds may only have a straw coloured logitudinal stripe along one side; this stripe sometimes allows entry of molds to the kernel. The large, but damaged, kernels are often found during inspection of wheat samples at the Canadian Grain Commission; the grades of shipments of wheat can be affected by the presence of midge damaged seeds.

The volume and weight of badly affected kernels were reduced and 186 seeds occupied a volume of 2 ml and weighed 0.362 g; 186 normal kernels occupied a volume of 7.5 ml and weighed 5.50 g.

Table 1 shows that the orange wheat blossom midge was found in all of the districts covered by Agricultural Representatives; this means that midges could become a menace to wheat culture in any part of Manitoba if conditions for the proliferation of this species become favorable. Of the fields examined, only 14% did not produce samples with either damage or midges. The proportions of fields which had more than 3, 4, or 5% damage due to the midge were 39, 29, and 23%, respectively.

There was considerable variation in the amount of damage produced in samples from different fields of wheat within a district. Thus, damage in Swan River samples ranged from 0.0 to 25.7% and in The Pas samples, damage varied from 4.3 to 18%. An investigation must be done into the causes of variability between levels of infestation of different fields in the various districts; the information obtained could be of value in the determination of agricultural practices which minimize the effects of midges to wheat.

The zone where midges were most prevalent during 1984 extended from Beausejour, and Selkirk in the south east to Roblin, The Pas and Swan River in the north western part of the wheat growing area of Manitoba. Some samples from the Red River Valley (Altona and Steinbach) and from Interlake (Teulon and Lundar) also showed considerable damage.

Comparison of the 1957 and 1984 data was difficult because average numbers from three fields were presented for each locality examined during 1957 and there is no record of the variability between one field and another within each district. The main difference between the two surveys is that no midges were found in the Brandon, Neepawa and Swan River districts during 1957.

This survey did not indicate whether the midge populations were static, rising or declining; only further surveys during the next growing seasons will show population trends. However, the populations at Glenlea do not seem to have changed much during the past three years, since damage levels have gone from 4.9% in 1982 to 3.6 in 1983 for irrigated fields (Barker, 1983b), but on unirrigated land there was a 2.3% loss in 1983 and a 2.7% loss in 1984. The losses incurred for 1984 on irrigated land have yet to be determined.

Though this survey indicated approximate levels of damage in different parts of Manitoba, it only allowed a guess at the total economic impact of the pest on the provincial economy. No attempt was made to determine the level of damage at which chemical control measures would become economically feasible.

One field from The Pas was treated with Lorsban and it was the only field from that community which showed no infestation. Several fields in the Swan River district were also treated, and showed low levels of damage but, unfortunately, some untreated fields also showed equally low levels of damage. This information suggests that treatment may be a useful practice, but more data are needed to confirm this effectiveness.

No attempt was made to evaluate damage by the wheat midge to other crops such as barley.

CONCLUSIONS

The orange wheat blossom midge caused reductions of wheat yield in all of the wheat growing districts of Manitoba. Losses can be expected to occur in the future, particularly near to Selkirk, Swan River, and The Pas, but only yearly surveys for midges and their damage can indicate whether or not higher levels of yield loss can be expected.

ACKNOWLEDGEMENTS

I thank Mr. D. Smith, Mr. A. Kolach, and the Agricultural Representatives of the Manitoba Department of Agriculture for their efforsts. Thanks are also due to Dr. Barrie Campbell for samples from Glenlea. Thanks are due to E.E. Lindquist and Suzanne Allyson for identification of the mites and the wheat head armyworm. Thanks are due to Dr. A. Tekauz for examination of diseased seeds.

LITERATURE CITED

Allen, W.R. 1955a. The wheat midge, Sitodiplosis mosellana (Gehin). Ann. Conf. Manitoba Agronomists, p. 28-29.

Allen, W.R. 1955b. Surveys of insects attacking cereal crops (E. 11.01-1). Entomology Laboratory, Brandon, Manitoba, Report of activities, August 1955.

Anonymous, 1956. Summary of insects of the season, 1956. Proc. Entomol. Soc. Manitoba. 12: 37.

Barker, P.S. 1983a. Damage to wheat in Manitoba by the wheat midge, Sitodiplosis mosellana (Gehin). Unpublished report, 3 p.

Barker, P.S. 1983. Damage to wheat in Manitoba by the wheat midge, Sitodiplosis mosellana (Gehin). Addendum A. Unpublished report. 6 p.

Bird, R.D., and Robinson, A.G. 1956. Important insects of 1956. Ann. Conf. Manitoba Agronomists. p. 29.

Ross, W.A. 1919. The identity of the wheat midge in Ontario. Can. Entomol. 51: 16.

Westdal, P.H. 1957a. The wheat midge, Sitodiplosis mosellana in Manitoba. Ann. Conf. Manitoba Agronomists. p. 32.

Westdal, P.H. 1957b. Surveys of insects attacking cereal crops. Annual Report, Winnipeg Research Station. (E.11.01-1).

Table 1. The percent damage to wheat by the orange wheat midge, Sitodiplosis mosellana, in various localities of the province of Manitoba during the 1984 growing season.

Locality	Percent damage in sample				
	1	2	3	4	5
Altona	1.3	0.0	0.6	0.3	6.0
Ashern	0.2	0.6	0.0	1.3	0.3
Beausejour	0.3	3.3	3.7	3.7	1.3
Boissevain	0.3	0.0	2.0	0.0	0.0
Brandon	1.1	0.0	0.6	0.0	-
Dauphin	0.3	2.0	0.8	2.3	-
Gladstone	3.0	0.0	0.0	4.7	0.0
Glenlea	2.7	-	-	-	-
Killarney	1.3	1.0	0.0	1.3	0.6
Lundar	1.3	0.0	0.0	0.6	4.7
MacDonald	2.0	0.8	1.3	0.0	0.0
McCreary	2.0	4.7	2.0	-	-
Minnedosa	0.3	0.9	0.3	0.0	3.4
Neepawa	0.0	1.0	0.0	0.3	0.0
Portage la Prairie	0.3	-	-	-	-
Roblin	1.7	6.0	2.7	3.0	-
Selkirk	4.7	3.5	11.5	5.3	6.8
Souris	0.7	2.7	3.0	2.0	1.0
St. Pierre	3.0	0.0	1.3	0.0	1.6
	1.0	1.0	-	-	-
Ste. Rose	1.0	0.6	0.3	-	-
Steinbach	4.9	3.3	0.6	5.2	2.0
Stonewall	3.0	0.0	2.3	0.0	1.3

continued

Table 1. (cont'd) The percent damage to wheat by the orange wheat midge, Sitodiplosis mosellana, in various localities of the province of Manitoba during the 1984 growing season.

Locality	Percent damage in sample				
	1	2	3	4	5
Swan River	0.4	0.8	0.0	14.3	0.8
	0.3	4.0	4.5	0.0	7.2
	2.6	12.5	4.5	3.2	8.4
	3.1	1.9	1.1	3.0	6.8
	5.7	2.5	1.8	19.2	4.5
Swan River	0.4	2.9	0.5	6.5	0.4
	0.0	0.3	3.3	0.6	10.5
	4.1	2.6	2.5	9.5	6.3
	1.6	7.7	5.0	19.2	8.4
	25.7	1.3	2.4	10.1	3.2
Swan River	1.7	9.2	6.2	6.1	8.2
	1.1	2.9	5.7	6.2	6.8
	7.2	3.8	3.0	1.6	13.6
	16.0	3.2	2.7	1.2	0.8
	6.2	0.3	0.0	18.6	7.7
Swan River	1.0	6.1	11.6	10.8	20.7
	1.6	6.7	1.2	0.3	1.3
	8.4	15.0	1.6	0.2	1.5
	2.0	3.0	1.7	1.7	4.8
	2.4	13.9	8.7	7.2	0.3
	0.0	2.6	7.3	7.5	0.3
Swan River	1.0	3.0	0.0	9.0	4.4
	0.0	0.7	0.4	1.0	-
Teulon	1.0	6.7	1.0	3.0	3.3
	3.3	0.6	0.3	-	-
The Pas	4.3	8.3	0.0	12.7	18.0
Virden	0.6	1.3	0.0	0.0	1.3

AGRO-MAN SOYBEAN PROJECT

JOE Y. TSUKAMOTO
MANITOBA AGRICULTURE

The Agro-Man Programme began when the Federal-Provincial General Development Agreement was signed by the Governments of Canada and Manitoba in 1973. The governments' concern was diversification and increased output of products for agricultural processing. Early in 1977 committees and sub-committees were established to consider possibilities; and immediately thereafter investigating and planning programmes began. A delay occurred because of a change in the provincial government, but finally some proposals were approved early in 1979. The programme became known as the Agro-Man Programme. The soybean project under this programme was approved on February 20th, 1979, and began in April, 1979.

The objectives for the soybean project were to develop technology for and demonstrate the commercial production of soybeans. This included increasing selected soybean cultivars; carrying out the investigations; demonstrating technology at farmer cooperator sites; and investigating the commercial suitability of processing soybeans grown in Manitoba.

A system to deliver the projects had been organized in 1979; and the soybean project, therefore, followed this system throughout its duration (see Appendix 1).

Accordingly, up until 1982, all cooperators were selected by agricultural representatives in the area where soybean production demonstrations were conducted. In 1983, when prospective new cooperators were not found outside the Pembina Triangle area, new cooperators were selected. Some were chosen by the agricultural representatives from Altona and Morden; and staff from CSP Foods Limited also assisted in selecting farmer cooperators. Collectively there were enough farmer cooperators to produce an adequate amount of Maple Amber for crushing in the fall of 1983. Since 1979, an aggregate of 129 farmer cooperators have taken part in the soybean production demonstration.

The Project Steering Committee is officially known as the Soybean Technical Committee. The committee discusses the plans for the project's annual activities. Research with soybeans and other related matters also are discussed at the technical committee's meetings so that the members have up-to-date information about soybeans in Manitoba.

Each season, the weather influences crop production in Manitoba. Of course, soybeans are no exception, with weather influencing every stage of plant growth. Consequently, yields varied with variations in the weather. A dry spring caused irregular germination. Cool spring weather delayed germination. Cool summer weather slowed plant growth. Moisture stress during the flowering period somewhat reduced the number of pods. Moisture stress during the time of seed development reduced seedsize. Prolonged drought, as occurred from July to harvesting time in 1983 and again in 1984, resulted

in soybeans maturing quickly toward the end of the season. Yields were reduced due to moisture stress; however, soybeans have been found to be more tolerant to high temperatures than many other crops now grown in Manitoba. Also soybeans have been found to be more tolerant to frost than field beans, but less tolerant to frost than faba beans. The early fall frost that occurred on August 27th, 1982, caused from light to severe damage to soybeans. As anticipated, late maturing soybeans received severe frost damage.

In 1979, a photo period insensitive variety, Maple Presto, a "000" type, was developed by Agriculture Canada, Ottawa. The introduction of this variety and this type of soybeans extended the possible soybean production areas in Manitoba.

In 1981, the variety McCall became a recommended variety for Manitoba in areas where the growing season is adequate. This variety was developed in Minnesota. It is a late maturing variety in Manitoba. It is a "00" type of soybeans. It has white hilum. The seed is not uniform in size, but McCall is a high yielder.

The variety Maple Amber was licensed and became a recommended variety in 1982. This variety was developed by Agriculture Canada, Ottawa. It is a "000" type of soybeans. It is later in maturity than Maple Presto; and it matures about two days earlier than McCall. It has dark brown hilum. Under ideal growing conditions, this variety produces large uniform seed.

The variety KC20, the first private variety, was developed by King Grain Company, Ontario. This variety was recommended in Manitoba in 1983. It has white hilum beans with a good protein content which are suitable for food processing in Japan. This variety is considered a "00" type of soybeans. It matures about two days later than Maple Amber. In commercial scale production in Manitoba, it appears to develop pods earlier than Maple Amber and to mature almost at the same time as Maple Amber.

The variety Maple Ridge was licensed in 1984. When this presentation was being prepared, it was proposed for inclusion in the 1985 Manitoba Field Crop Recommendation Guide. This soybean has white hilum, matures a few days earlier than Maple Amber, and has quality and yield equal to or better than Maple Amber.

The development of new improved varieties is ongoing in both public and private institutions.

During the span of the Agro-Man Program, the soybeans project used three varieties, Maple Presto, McCall and Maple Amber. In 1983, an adequate amount of Maple Amber seed became available; and the project in almost all cases changed over from other varieties to Maple Amber. Maple Amber is a good yielder, and it is higher in protein than other varieties when they are grown under the same conditions. The protein content of soybeans is one of the important factors in the sale of soybean meal after the oil has been extracted. Normally, the market place has 44 per cent protein as its basis. In the market place, soybean meal generally has 8 to 11 per cent moisture.

During any year from 1979 to 1984, there was an average of 821 kg/ha to 1062 kg/ha from Maple Presto; 715 kg/ha to 1480 kg/ha from McCall; and 1284 kg/ha to 1345 kg/ha from Maple Amber; however, there was a great deal of variation in yields among cooperators and in different years (see Appendix 2). There are many reasons for this variation, but certain factors, aside from the weather, seem to occur.

(1) Poor selection of field. Heavy clay soil normally results in slow emergence. There is a tendency toward great pressure from weeds because the incorporation of herbicides into the soil tends to be poor, and their effectiveness during the cool spring is slow or weak. The result is weedy fields.

(2) Too deep seeding. This is often the case with first year cooperators. The result is poor stands of soybeans. Thin stands often result in a weedy field because a second and third flush of weeds emerge.

(3) Poor incorporation of pre-plant, soil incorporated herbicides.

(4) Untimely application of post-emergence herbicides.

(5) Untimely harvesting and incorrect adjustment of the combine and the ground speed of the combine.

Because effective post-emergence herbicides have become available to control grassy weeds and broadleaf weeds, good control of weeds in the soybean field is not as difficult a task as it was in the past. Timely applications of post-emergence herbicides are extremely important in controlling weeds.

The Agro-Man variety trials, conducted by the University of Manitoba, show much higher yields of soybeans (see Appendix 3). Also, the protein content of soybeans is uniformly higher than of those grown in commercial fields. The difference may be partially explained in that under variety trials, soybeans were seeded at the proper depth and weeds were controlled completely. Variety trials are conducted on summerfallow which normally has higher available nitrogen. It is indicated that soybeans have a high yielding potential in Manitoba. Also, it is worth noting from the variety trials that soybeans can be grown in a much wider area than they are now grown in Manitoba.

When new soybean varieties are introduced, processors want to know their crushing ability and the quality of oil and meal from them. It is important to establish a new variety's commercial acceptance by processors before it is grown in a large volume.

When Maple Presto and Maple Amber were introduced, they were crushed at POS Pilot Plant, Saskatoon. At the time that Maple Amber was crushed, it was noted that the protein content of soybean meal was high. For both varieties, the quality of oil was satisfactory and also the quantity of oil extracted was good. Processors had their staff present as observers during the crushing.

The uniqueness of the soybean project, compared with projects

that are contracted out to farmer organizations, is that there must be continuity in the production of soybeans in order to meet the needs of the processors. When the project is terminated, soybean production and processing in Manitoba will continue to expand. From the beginning this project had good relations with CSP Foods Limited. Particular assistance was extended to the project when, in 1983, it was difficult to create an interest among farmers to cooperate in growing soybeans after an early frost damaged soybeans in 1982. The staff of CSP Foods Limited assisted in selecting good cooperator As a result, there was a close relationship between the soybean producers and the processor in the areas of Altona, Plum Coulee and Winkler. This resulted in timely seeding and in the timely application of herbicides which brought about the successful production of soybeans. The staff of CSP Food Limited also continued a dialogue with staff from Manitoba Agriculture throughout the year. Joint field observation tours to soybean fields and discussions about possible improvements in soybean production often resul ed.

Nodulation on the root system of soybeans grown in Manitoba generally is found to be inadequate. For this reason, unless soil is high in available nitrogen, soybeans produced from poorly nodulated plants in fields that have low available nitrogen are low in protein.

Fields that have received granular inoculum form abundant active nodules, provided granular inoculum is placed properly with the seed at the time of seeding. Soybeans obtained from such fields appear to have adequate protein to produce soybean meal with 44 per cent protein. It appears that there is a need for rhizobium for vigorous and quick forming nodulation which is active until soybeans reach maturity under Manitoba conditions.

From this project, it is apparent that soybeans can be grown commercially in Manitoba. Manitoba grown soybeans generally have a satisfactory quality and quantity of oil, but protein is low. It was found that in general nodulation on the root system of soybeans is poor in Manitoba. Fields high in available nitrogen produce soybeans with adequate protein; however, it is anticipated that an application of a high rate of commercial nitrogen fertilizer will bring about luxuriant plant growth and invite an infestation of white mold (Sclerotinia wilt). With the exception of white mold, diseases which are considered to be of economic importance were not found with soybeans. Some minor diseases found are Rhizoctonia, bacterial blight, Downy mildew and Alternaria leaf spot. It is important to keep disease to a minimum at all times. The use of disease free seed and the stringent practice of crop rotation with soybeans are recommended. Cutworms, grasshoppers and seed maggots were the only insects observed in the commercial field of soybeans.

During the project, the cost has risen from $57.05/ha to $99.70/ha for herbicides; whereas, the cost of fertilizer has been reduced. Commercial soybean prices have fluctuated as oil seed does from $5.75 (27.3 kg) to $9.25 (27.3 kg). The worst was experienced in 1982 when frost damage reduced yields and the commercial price of soybeans was low ($5.75 per 27.3 kg). Such years as 1982 cause a severe set back in the introduction of any new crops which are not

familiar to the general producer. The hectarage of soybeans during the period of the project was estimated to be 202 ha, 1979; 728 ha, 1980; 1514 ha, 1981; 2527 ha, 1982; 3642 ha, 1983, and 5666 ha, 1984.

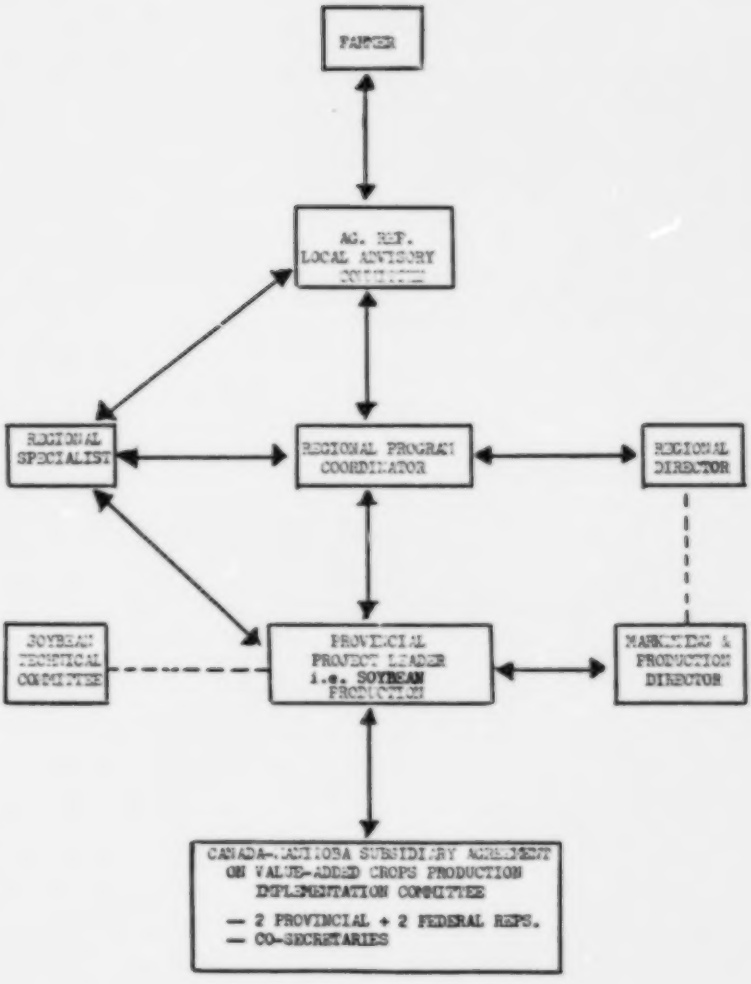
The objective of the Agro-Man Soybean Project is to process soybeans in Manitoba. However, as with many developments, there is a spinoff with this type of project. Recently Japanese buyers expressed interest in Manitoba grown soybeans for their food processing. They are interested in small soybeans for manufacturing special food and in white hilum soybeans for manufacturing soybean curd and soybean paste. In exporting Manitoba grown soybeans to Japan, there will be stiff competition from the People's Republic of China. Quality, reasonable prices and availability of a consistent supply are necessary in competing with the Chinese.

Throughout the Agro-Man Soybean Project, a weakness existed in not providing on-the-spot assistance to the cooperators, particularly those who were not familiar with special crops which require extra attention such as seeding at the right depth, not too deep, and applying post-emergence herbicides at the right time. Occasionally, for unknown reasons, herbicides do not effectively control weeds, and another application of the same or another herbicide is needed but it is not applied on time or at all. These mishaps often could have been prevented if there had been someone from the extension staff frequently at the demonstration sites but this was not always possible. For this reason, the selection of cooperators who are able to perform these tasks correctly is needed. This may best be done through firms that are interested in soybean production and also have had experience with farmers in the production of other special crops. These firms know the farmers who have experience in growing special crops. Should a similar project be undertaken in the future, it is my opinion that if it is at all possible such a project be undertaken jointly by industry and Manitoba Agriculture, including the extension staff which provides the necessary information and organizes extension activities.

Throughout the project, field days, short courses and seminars were held to make producers aware of the possibility of soybean production in Manitoba. A brochure about growing soybeans in Manitoba was up-dated by a group of researchers and extension staff members three times during the course of this project. People from television, radio and the press also assisted in making the public aware of soybean production in Manitoba. There always is a need for comprehensive lateral coordination and for cooperation from related organizations if these programmes and projects are to function meaningfully.

APPENDIX 1

AGRI-MAN
PRODUCT DELIVERY SYSTEM ORGANIZATION



1979-1984 AGRO-MAN SOYBEAN PROJECT
YIELD IN kg/ha

LOCATION	1979	1980	1981	1982	1983	1984
	MAPLE PRESTO	MAPLE PRESTO				
Melita	1/ 635					
Elgin	2/ 577	-	-	-	-	-
Niverville	605	669	-	-	-	-
Portage la Prairie	807	667	-	-	-	-
Thornhill	1365	690	-	-	-	-
Altona	1534	1257	-	-	-	-
AVE.	821					
			MAPLE PRESTO			
Vita	-	1098	-	-	-	-
Beausejour	-	1134	673	-	-	-
Hamiota	-	964	-	-	-	-
Cypress River	-	885	-	-	-	-
Lyleton	-	775	-	-	-	-
Oak Bank	-	2/ 548	-	-	-	-
Whitemouth	-	1120	-	-	-	-
Pilot Mound	-	570	-	-	-	-
AVE.		846				
KILLARNEY	-	-	874	-	-	-
Souris	-	-	1345	MAPLE PRESTO		
Ste. Rose	-	-	1009			
Dauphin	-	-	1009	-	-	-
Brandon	-	-	1211	3/ 807	-	-
Gladstone	-	-	673	4/ 471	-	-
Warren	-	-	942	-	-	-
AVE.			1009			
Wawanesa	-	-	-	1480	-	-
Killarney	-	-	-	1480	-	-
AVE.				1062		
			McCALL	McCALL		
Landmark	-	-	1345	4/ 471	-	-
Ste. Malo	-	-	1345	-	-	-
Lyleton	-	-	1009	-	-	-
Labroquerie	-	-	673	-	-	-
Beausejour	-	-	1009	-	-	-
Carberry	-	-	2018	-	-	-
Brandon	-	-	942	-	-	-
Tourond	-	-	2152	4/ 874	-	-
Portage la Prairie	-	-	2287	-	-	-
Beausejour	-	-	1345	-	-	-
Emerson	-	-	1480	4/ 605	-	-
Emerson	-	-	2018	-	-	-

APPENDIX 2

1979-1984 AGRO-MAN SOYBEAN PROJECT
YIELD IN kg/ha

LOCATION	1979	1980	1981	1982	1983	1984
Selkirk	-	-	1009	1/ 404	-	-
Rosser	-	5/ -	1547	-	-	-
Altona	-	-	2018	1/ 807	-	-
Holland	-	-	2018	1/ 673	-	-
Portage la Prairie	-	-	1480	1070	-	-
AVE.			1480			
Wackada	-	-	-	1177	-	-
Altona	-	-	-	1170	-	-
Emerson	-	-	-	1/ 807	-	-
Emerson	-	-	-	1/ 807	-	-
Carberry	-	-	-	1/ 740	-	-
Gladstone	-	-	-	1/ 605	-	-
Teulon	-	-	-	1/ 538	-	-
Souris	-	-	-	1/ 538	-	-
Carberry	-	-	-	1/ 471	-	-
Ste. Rose	-	-	-	1/ 336	-	-
AVE.				715		
				MAPLE AMBER		
Dauphin	-	-	-	1/ 538	MAPLE AMBER	MAPLE AMBER
Altona	-	-	-	-	2078	1681
Greina	-	-	-	-	1701	1547
Altona	-	-	-	-	1695	1547
Altona	-	-	-	-	1681	1614
Halbstadt	-	-	-	-	1681	-
Winkler	-	-	-	-	1648	1/ 942
Rosenfeld	-	-	-	-	1627	1883
Wawanesa	-	-	-	-	1614	-
Altona	-	-	-	-	1614	1076
Horndean	-	-	-	-	1574	1614
Plum Coulee	-	-	-	-	1547	1211
Altona	-	-	-	-	1547	2152
Ste. Anne	-	-	-	-	1547	-
Altona	-	-	-	-	1473	1345
Altona	-	-	-	-	1365	1211
Carberry	-	-	-	-	1345	-
Killarney	-	-	-	-	1345	-
Altona	-	-	-	-	1211	1211
Altona	-	-	-	-	1083	1076
Carberry	-	-	-	-	1009	-
Winkler	-	-	-	-	1480	1/ 673
Rosenfeld	-	-	-	-	1473	1211
Altona	-	-	-	-	1345	1345
Altona	-	-	-	-	1211	-

APPENDIX 2

1979-1984 AGRO-MAN SOYBEAN PROJECT
YIELD IN kg/ha

LOCATION	1979	1980	1981	1982	1983	1984
Winkler	-	-	-	-	1143	-
Altona	-	-	-	-	1076	1143
Altona	-	-	-	-	5/ 982	1076
Altona	-	-	-	-	2/ 874	1076
Altona	-	-	-	-	7/ 565	1547
Altona	-	-	-	-	8/ 336	-
Plum Coulee	-	-	-	-	1143	-
Plum Coulee	-	-	-	-	1110	-
Gretna	-	-	-	-	976	1076
Rhineland	-	-	-	-	9/ 581	-
Winkler	-	-	-	-	1177	1681
Winnipeg Beach	-	-	-	-	1/ 578	-
AVE.					1284	1345

1/ Infestation of weeds

2/ Volunteer crops

3/ Poor harvesting

4/ Early fall frost damage

5/ Completely destroyed by hail

6/ Moderate hail damage

7/ Moderate to severe hail damage

8/ Severe hail damage

9/ Seeding mishap

APPENDIX 5

1980 - 1984
MANITOBA CROP ADAPTATION TRIALS
MEAN YIELD IN kg/ha

LOCATION	MAPLE PRESTO	MAPLE AMBER	McCALL	MAPLE RIDGE	KC20
Waskada	2243 3/	2366 4/	2634 4/	2652 3/	-
Souris	2491 3/	2628 4/	2791 4/	2520 3/	2597 2/
Mariapolis	2149 2/	2474 3/	2995 3/	2585 2/	-
Shoal Lake	2038 3/	2221 3/	2141 3/	2213 3/	3106 2/
University Of Manitoba	2567 5/	3228 5/	3330 5/	3207 4/	3517 2/
Dauphin	2518 5/	2615 5/	2576 5/	2956 4/	2804 2/
Bagot	2275 5/	2703 5/	2934 5/	2767 4/	3001 2/
Teulon	1956 4/	2137 4/	2387 4/	2433 4/	2467 2/
Vita	2172 5/	2620 5/	2429 5/	2845 4/	1952 2/

2/, 3/, 4/ and 5/ indicate the number of years they were tested.

Conducted by: The Department of Plant Science
University of Manitoba
WINNIPEG, Manitoba

SAFFLOWER - A POTENTIAL CROP FOR MANITOBA?

J.G. NIELSEN, FARMER - AGRICULTURAL CONSULTANT

GOODLANDS, MAN.

Introduction

The following presentation on safflower production and its potential as an alternate crop in Manitoba is based on my experience gained from growing the crop for the last two years, from discussions with two MDA specialists, J.S. Tsukamoto and Owen Beaver, and from a bulletin entitled Safflower in North Dakota prepared by B.K. Hoag, E.W. French, G.N. Geiszler and A.A. Schneiter from the North Central and Williston Branch Stations, Agricultural Experiment Station and the North Dakota State University, Fargo, North Dakota.

I grew 20 ha of safflowers in 1983, a year with moderate soil moisture reserves at seeding, 150 mm of precipitation during the growing season, however July and August were extremely hot. The crop was seeded in early May, was generally weed free, and was harvested dry in late September at a yield of 1200 kg/ha. In 1984, with good soil moisture reserves at seeding, a cooler summer, and only 40 mm of precipitation during the growing season the crop still produced 1200 kg/ha.

Safflowers are an annual oilseed crop which have been grown successfully on summerfallow for twenty years in the drier areas of Western North Dakota. Fewer hectares are grown east and north of Minot as precipitation levels have normally allowed for continuous cropping resulting in more difficulty in obtaining adequate weed control in safflowers, little economic advantage when compared to wheat and sunflowers and a considerable increase in the risk of serious yield reduction due to disease. Over the past few years the drier climatic trends in South West Manitoba have allowed for or even encouraged the introduction of this drought resistant crop. Disease infestation has not been a problem. In 1984 over 4,000 ha were contracted and grown in the Deloraine, Waskada, Melita, Elgin areas and it is projected that this acreage will increase in 1985.

Safflower oil is an important edible oil, and is used in the paint and varnish industry. It has found a place in the birdseed market and the residue from the oil extraction process is a protein supplement used in cattle, sheep and poultry feeds.

Characteristics

Safflower, an annual oilseed crop belongs to the same plant family as sunflowers and thistles. The thistle-like plant has a strong central stem, a tap root, and varying numbers of branches depending on plant densities. It grows between 40 to 80 cm in height, depending on water availability, takes 110 to 150 days to mature, and has one to five round erect seed heads when planted in 15 cm rows, with 15 to 30 seeds per head. The safflower I have grown was provided by the contractor and had yellow flowers.

Each seed takes one to three weeks to germinate, and forms one central stem. Elongation does not take place for several weeks so the leaves develop near the ground in a rosette. During this period the plant does not compete well with weeds.

The plant is very prickly once elongation occurs and it is virtually impossible to walk in the field prior to ripening. After ripening the crop is not difficult to handle.

Safflower grows best on fertile well drained medium to fine textured soils with good stored soil moisture levels. It also can be grown on coarse textured soils if rainfall is adequate. It is highly saline tolerant.

The paper from North Dakota states that the crop prefers dry atmospheric conditions. East of Minot higher humidity and dew occur more often and can cause infection during flowering and filling and the development of leaf spot and head rot diseases which can seriously reduce yields.

Disease has not been a problem in my crops the past two years. The contractor states that some farmers in northern North Dakota have grown safflowers continuously for 15 years with few disease problems.

An Alternate Crop, Thanks to Research and Extension

When I returned to our family farm in 1981 I talked to my successful neighbours and selected the crops predominantly grown in the area. Wheat, of course, is the main crop however for rotational, marketing, and speculative profit considerations sunflowers, canola, flax and barley are grown. I chose not to grow sunflowers due to lack of appropriate machinery and the fear of having to combine at Christmas. Over the next two seasons, one dry and one normal, I was not pleased with the production from canola, flax or barley. I had heard about safflowers and since they could be grown with conventional machinery I decided to plant a small field in 1983. At this time I want to thank Joe Tsukamoto and Owen Beaver of MDA Brandon for the time spent, interest shown, and information provided on how to grow safflowers. Armed with their advice and the research papers from North Dakota I seeded the safflowers and when some broadleafed plants came up in rows I assumed that they must be safflower plants. I had never seen the crop grown however this crop grew well over the summer and produced a reasonable yield. I was very pleased to be able to grow a good clean crop the first year and I give most of the credit to the research and extension professionals. I want you to know that this Manitoba farmer respects and appreciates your contribution to our industry. Thank you!

The decision to grow safflowers was based upon the following considerations:

- safflowers are a drought tolerant crop and therefore less sensitive to warmer temperatures and low precipitation compared to canola, barley and flax,
- the crop is highly saline tolerant,
- Treflan could be used for weed control,
- seeding depth was similar to wheat and the seeding rate was amply high enough to create little concern when using a double disc press drill,
- insects were not a problem, even grasshoppers refuse to eat safflowers,
- the crop would dry down in September and could be straight cut or swathed and combined and a dryer was not required, and
- the crop was grown under contract so a market was assured.

I had the following reservations with the decision to grow safflowers:

- could adequate weed control be achieved , and
- the contract price offered was so low that the only justification to grow the crop was to test its suitability to the farm and gain experience in the production techniques required to grow the crop.

Contract

Safflowers are grown under contract with a specified price per kg for the first 1080 kg/ha grown. In 1983 and 1984 my contracts were for 22.0 and 29.7 cents per kg, respectively. In both years the crop graded #2 resulting in a price reduction of 2.2 cents per kg. The lower grade was due to "weather staining" even though fall rains were not a problem. I would suggest that economic justification to produce the crop be based on the price of grade #2 safflowers. Care must be taken if swathing to assure stones are not picked up or the sample will be rejected.

Seeding

Safflowers are normally seeded from April 20 to May 10 in 15 cm rows with a standard wheat seeder. The recommended seeding rate in North Dakota at this spacing is 30-36kg/ha. For wider spaced rows, up to 90 cm, 18-30 kg/ha may be seeded. My contractor recommended I seed at 18 kg/ha the first year; this was too low a rate. I seeded at 27 kg/ha this year and had a reasonable plant population. I will seed from 27-30kg/ha next year.

I applied and worked in treflan just prior to seeding and planted the crop the same depth as wheat.

Weed Control

I applied Treflan at the normal rates for canola or sunflowers and have spot sprayed wild oats with Hoe Grass. I have not encountered wild mustard or french weed infestations however my contractor uses a combination of Poast and 2.5 g/ha of Glean to control these weeds. The mix is not registered however he states that he has controlled weeds, the crop has not been damaged, and the residual characteristics of Glean were not apparent in following crops.

Row cropping safflowers is an alternate method which could be used to obtain weed control by inter row tillage. North Dakota results show that the highest yields of safflowers were obtained from narrow row planters, 15 to 25 cm, however 53 cm row spacing resulted in only a slight yield reduction. Considerable yield reductions resulted when safflowers were planted in 90 cm rows. Row cropping allows for improved weed control and may result in less moisture utilization therefore influencing the yield of the subsequent crop.

It is suggested in the North Dakota literature that a tine harrowing may be conducted to kill small weeds when the safflowers are seven cm in height.

Fertility

I used a 48N - 24 P_2O_5 kg/ha application rate for the safflowers. Anhydrous Ammonia was knifed in prior to planting and granular 11-51-0 was applied with the seed. There is some debate in relation to the response of safflowers to nitrogen, however, having been indoctrinated by the Soil Scientists at the University of Manitoba I will continue to add nitrogen.

Harvesting

Safflowers may be harvested with conventional small grain combines. Straight cutting is preferable however swathing and combining is also possible. Swathing may be necessary to allow for weeds to dry. If the swath is to be left for any period of time it should be rolled.

Since I do not have a straight cut header I have swathed the crop both years. Due to the very fluffy nature of the safflower swath the crop was combined immediately.

Economic Comparison of Safflowers with Wheat, Sunflowers, and Canola

Safflowers will have a place in the farmers rotations in south-west Manitoba because the crop is drought resistant, will provide a reasonable return and is very easy to grow and manage. Compared to sunflowers, specialized equipment is not required, there are no insect problems and the crop can be harvested a month earlier. Compared to canola the crop does not have the problems associated with small seed, shallow seeding, and proper stand establishment. Insects are not a problem and safflowers stand well at harvest and do not shell. Many of my neighbours do not appreciate the management problems associated with growing canola and sunflowers; the returns must accrue to warrant the additional headaches.

The comparative yields and returns on my farm in 1983 and 1984 are shown on Table one. My experience with safflowers over the past two years has been positive. It is comparable to or even more drought resistant than wheat. I believe it will replace barley and flax in my rotation and very likely canola especially if a dry year is anticipated. I do not believe that it will produce as well as sunflowers, however, increasing insect and Sclerotina rot problems may reduce sunflower acreage. In order to be a viable crop the contract price must be maintained and remain competitive with other oilseeds.

Safflowers have a place on my farm and now they should find a place in your research programs, extension programs, and the Crop Insurance program.

Table 1: A Comparison of Yields and Returns from Safflowers, Wheat Sunflowers and Canola Grown in 1983 and 1984.

Year and Conditions	Crop and yield kg/ha	Price/kg $/kg	Gross/ha	Comparative Gross/ha
1983				
- moderate soil moisture, 45-60cm wet soil at seeding	Safflowers 1120 kg/ha	0.198 [1]	$222.00	$222.00
- 15cm rainfall in growing season with 12mm in June	Wheat [2] 1800 kg/ha	0.18	$324.00	$324.00
- very hot July and August	Sunflowers 1200 plus	-	$408.00	$358.00 [3]
	Canola 780 kg/ha	0.386	$301.00	$301.00
1984				
- excellent soil moisture - 75cm plus	Safflowers 1120 kg/ha	0.275	$308.00	$308.00
- 40mm rainfall through growing season to late September	Wheat 1540 kg/ha	0.175	$270.00	$270.00
	Sunflowers [4] 840 kg/ha	0.310	$260.00	$210.00
- moderate temperature during summer	Canola [5] 610 kg/ha	0.380	$232.00	$232.00

1. grade #2
2. Average yield wheat on 400 ha.
3. Gross income two large producers in area, extra production cost $50.00/ha subtracted from gross to give comparative gross.
4. Sunflowers, 68 ha grown, row cropped, row cultivated, custom harvested, extra production costs $50.00/ha subtracted from gross to give comparative gross.
5. 170 kg/ha below MCIC Insurance level.

MANITOBA PULSE GROWERS' ASSOCIATION

Who is the Manitoba Pulse Growers' Association Inc.? The MPGA is a group of people who are interested in the pulse industry in Manitoba. This group is made up mostly of crop producers, but does include some trade firms and other interested individuals, so you can see that we are not a paramedic or Doctors group or any other image that you may have formed by hearing the name.

What is a pulse crop? The simplified definition which I use is that a pulse is a leguminous plant which produces a dry edible seed. The crops this definition currently covers include dry field peas, field beans, lentils, fababeans, and soybeans.

Why a Pulse Growers' Association? The growing of some of the pulse crops has been carried out more or less successfully for many years. For example, field pea production dates back over 20 years. The lentil growers in Manitoba formed an association in the early seventies, but this group was short-lived. The number of producers was just too small at that time to be viable. By 1981 however, the census of that year shows that there were 2,221 pulse growers in this province. Allowing for some overlapping, (the same farmer growing more than one pulse crop) estimates range from 1500 to 1800 pulse growers for that year. That is a significant number of people who at that time were relying entirely on the trade firms, contractors, chemical company reps and the personnel from Agriculture Canada or Manitoba Department of Agriculture to provide them with information on production of these crops. That is not to downplay these sources of information, for they have been and still are very valuable to producers. The problem lay in getting the best information to the most producers possible in the shortest amount of time. Also, was the research work being carried out in areas of greatest concern to the largest number of producers? As individual growers, we could only hope that someone of influence would take up our personal production problem, and research or manufacture or otherwise help solve this problem with us. There was no one to speak on our behalf to researchers, government bodies, chemical companies, etc., etc., and conversely, there was no one for these parties to turn to for guidance of direction, purpose, programs, etc., etc. again.

A moment ago, I said "more or less successfully". 1982 was "less successfully" to say the least, in many areas of the province. The severe disease outbreaks with resulting low yields, low quality, and low prices brought the situation to a head. In early June 1983, an initiative was taken to get representative growers of all pulse crops, some processors, and MDA personnel together to discuss formation of a broad-spectrum pulse growers organization.

Now, how to proceed with the formation of a province-wide pulse growers' association? At the second meeting of the interested parties, an interim committee was formed to prepare a draft constitution, develop objectives, and poll growers for opinions. Plans were made to hold field days and information sessions at 4 locations in the Province. A notice of the field days plus an opinion reply form was mailed out to

producers through the contracting and processing firms located in Manitoba. The results of these measures led to a formational meeting being held at Portage on November 21, 1983. A proposed constitution and by-laws was presented to those in attendance, and by unanimous vote, the Manitoba Pulse Growers' Association was formed. We have since been registered as an incorporated body in Manitoba.

To quote directly from our constitution, "The object of this Corporation shall be the advancement of Manitoba's pulse crop industry in all its phases". This is to be carried out by:

a) Holding an annual meeting for consideration of questions relating to the production and marketing of pulse crops;

b) Collecting and making available to its members useful scientific and general information on producing, storing, packaging, processing, transporting, marketing and utilizing of pulse crops;

c) Improving trade relationships and promoting consumption of Manitoba grown pulse crops;

d) Demonstrating desirable production and merchandising practises and research projects by means of field days;

e) Co-operating with other agricultural groups in the promotion of the welfare of pulse crop producers;

f) Using such other means as may from time to time seem desirable.

About the only thing we have excluded is the selling of product. We believe there would be duplication of effort between the trade firms and ourselves. There is good competition in this area already, and any effort expended by the Association in this direction would be largely wasted.

To keep in touch with the market aspect of pulse crops, we have two members of trade firms on our Board of Directors. These representatives are chosen by the Seed Trade Association of Manitoba. Also appointed to our Board is a member of M.D.A.; a representative of Plant Science, University of Manitoba; and a representative of the Research Branch, Agriculture Canada in Manitoba. To complete the Board of Directors, seven grower Directors are elected to represent the various crops and regions of the Province.

The Association's first year has been both ambitious and productive. One of the first actions of the Board was to meet with the Deputy and Assistant Deputy Ministers of Agriculture for Manitoba to explain to these gentlemen what the Association was attempting to achieve, and also to ask for their support. While they did not dump huge amounts of cash into our hands, they did provide very tangible support to the MPGA for which we are most grateful. Other activities included the following:

a) Inclusion in Pulse Days meetings as co-sponsors, speakers and sessions chairmen, as well as manning membership booths.

b) February 4/84 found most of our Directors in Lethbridge, Alberta for the formational meeting of The Western Canada Pulse Growers' Association. This body is made up of the Directors of the 3 prairie provincial associations, and is to deal with matters which concern more than a single province, e.g. crop price stabilization.

c) We have made up and had printed brochures, one of which explains the structure and objective of the MPGA and contains a membership application form. We have them here today and we are taking 1985 memberships! The second is a recipe sheet containing nutrition and preparation information as well as recipes.

d) A field day was held again this year at the Morden Research Station. A very informative day was enjoyed by all in attendance, and I have heard only favorable comments from all concerned with the program.

e) Many Board and Committee meetings were held throughout the year to deal with Association business. While time forbids any details here, I would like to express the appreciation of the MPGA Board members for the excellent co-operation of the chemical firms in helping to arrange and finance some of the larger meetings, such as the field day and the formational meeting. Their many offers of assistance are most gratifying to an organization with limited funds, such as ourselves.

f) While this is not an activity, I will mention that we have an observer representative at the meetings of the Senior Grain Transportation Committee. There is some hope that this position may be elevated to an active role in the future.

Of premier importance to the pulse growers is the area of research in a wide and varied range of items. We are hopeful that the WCPGA will be voted a seat on the Western Research Foundation Board of Directors, and we are working towards that goal. We believe that we can make a useful contribution to that body.

This past summer we had some new recipes developed, and work is underway on having them included in a brochure for consumers.

The MPGA has agreed to contracting a six component pulse crop prospectus with the Economic Regional Development Agreement, and we have an interest in some others which were submitted for consideration. At this time we do not know if the prospectus was accepted or rejected. Proposed are crop production demonstrations of dry green and semi-leafless peas, lentils, fababeans, flat peas and lupins.

Currently we are sponsoring a swine feeding trial at the Brandon Research Station. This first run is to evaluate the use of low quality lentils as a protein supplement in the diet. We see this information as being beneficial to pulse growers, processors, feed mills and hog producers. The MPGA is looking at this an an on-going trial, testing other pulses in the swine diet as space, time, money and product are available, and need for such testing is warranted.

It is through the auspices of the WCPGA that our producers have seen the most immediate and gratifying results of organization. At the formational meeting of the WCPGA a committee was struck to compile statistics and make application to the Federal Government for a stabilization payment on 1982 colored beans. Under the Canada Stabilization Act payments had apparently been available to Eastern growers for several years, but none had ever been paid to Western producers. The white beans have had somewhat better treatment, with at least 3 stabilization payments in the last six years, but only going to those producers who found out on their own or from their processor, that such payments were available. As a direct result of the WCPGA committee visit to Ottawa, a stabilization payment of $200.88 per tonne for the 1982 crop has been approved. Also, some doors have been opened and contacts are being maintained, so that a network is in place to handle any such problems and/or payments in the future. There is a six person committee in place to have the necessary groundwork of statistics ready for future use, with the intent of streamlining the procedures, resulting in earlier decisions re payouts for a given year. This present payment has taken over a year to receive approval, and the money is still not in the hands of the producers.

Just to note the importance of this one achievement, I will point out to you the following:

a) The support price was calculated at $573.44 per tonne. This represents 90% of the five-year average market price adjusted for increased production costs.

b) The total stabilization program for colored beans was announced to be 4.5 million dollars. Based on an estimated 3420 tonnes production for 1982, the Manitoba share is about $684,000.00.

c) Colored beans made up approximately 50% of the 1982 Manitoba bean production. Using the 1981 census figures and adjusting the number of growers downward in accordance with lower seeded hectares, the average payment per grower should be nearly $7000.00. While this is not a huge sum, it will certainly be helpful, in view of today's economic picture.

While we recognize that all farmers would greatly prefer strong prices instead of stabilization payments, the WCPGA, through the provincial associations, will be looking at all crops within our framework with regard to price stabilization. This program must again be tempered to the constraints of time and money.

At this time, I would invite anyone who is interested in the pulse industry to make a point of attending the First National Conference on Pulses being held at Saskatoon on January 8th, 1985. The viewpoint of Western producers may be very important at this meeting.

In conclusion, let me point out that the work which has been done in the past year is only a scratch on the surface of what still needs to be accomplished. To the pulse growers of Manitoba, this is your organization. It will only be as effective as you make it. Your input & support are vital in determining what can be achieved by the MPGA. Consider this to be comparable to planting your crop. If you leave it to someone else to do, it probably won't be done the way you would like

it to be done. To everyone else, we may do something which touches your life directly or indirectly. Your support of the Manitoba Pulse Growers' Association, Inc. in any manner will be greatly appreciated.

Thank you.

FORAGE/HERBICIDE SCREENING TRIALS

M. GOODWIN AND G. BONNEFOY

MANITOBA AGRICULTURE

The lack of herbicide recommendations for control of many weeds in forage crops limits efficiency of production. Field trials were established at Arborg and at Manitou in 1983 and at St. Claude and Oak Bluff in 1984 to determine the potential for expanding herbicide recommendations. The experiments included 17 grass species and 9 legumes sprayed with 19 herbicide treatments. Trials included both seedling and established stands. Herbicide treatments and species lists are given in Table 1. All plots were rates for tolerance 10 days and at six weeks after spraying. Further details on fertilization and planting are given in the 1983 Manitoba Agronomists' Conference Proceedings (p. 12).

Species	Treatments on Seedlings (Rate in kg/ha)	Treatments on Established (Rate in kg/ha)
Legumes		
alfalfa birdsfoot trefoil sainfoin alsike clover sweet clover red clover (single cut) red clover (double cut) cicer milk vetch common vetch	2,4-DB (1.4) MCPB + MCPA (1.3 + 0.1) MCPA Na (0.35) bromoxynil (0.3) linuron (1.2) bentazon (1.1) metribuzin (0.3) flamprop methyl (0.4) difenzoquat (0.8) diclofop (0.7) diclofop + bromoxynil (0.8 + 0.3) sethoxydim (0.35) fluazifop (0.1) Dowco 453 (0.35) dalapon (1.6) TCA (1.4) difenzoquat + 2,4-DB (0.8 + 1.4) TCA + difenzoquat + 2,4-DB (1.4 + 0.8 + 1.4)	2,4-DB (1.4) MCPB + MCPA (1.3 + 0.1) bromoxynil (0.4) bentazon (1.1) metribuzin (0.3) fomesafen (0.25) clopyralid (0.2) dalapon (1.6) flamprop methyl (0.4) asulam (1.7) difenzoquat (0.85) diclofop (0.7) fluazifop (0.25) sethoxydim (0.35) DPX Y6202 (0.15) propanil (1.0) asulam + 2,4-DB (1.1 + 0.6) diclofop + bromoxynil (0.8 + 0.3)
Grasses		
timothy orchardgrass bromegrass reed canarygrass Kentucky bluegrass	difenzoquat (0.8) diclofop (0.7) flamprop methyl (0.6) fluazifop (0.25) propanil + MCPA (1.0 + 0.3)	difenzoquat (0.8) diclofop (0.7) flamprop methyl (0.6) propanil + MCPA (1.0 + 0.3)
Altai wild ryegrass Russian wild ryegrass tall fescue meadow fescue	2,4-DB (1.4) MCPB + MCPA (1.3 + 0.1) bromoxynil (0.4) bromoxynil + MCPA (0.3 + 0.3)	2,4-DB (1.4) MCPB + MCPA (1.3 + 0.1) MCPA amine (0.55) bromoxynil +
creeping red fescue	cyanazine + MCPAK (0.3 + 0.6)	MCPA (0.3 + 0.3)
tall wheatgrass intermediate wheatgrass	dicamba (0.3) linuron + MCPA (0.3 + 0.55)	dicamba (0.3) bentazon (1.1)
crested wheatgrass slender wheatgrass pubescent wheatgrass streambank wheatgrass meadow foxtail	clopyralid (0.3) metribuzin (0.3) bentazon (1.1) MCPA amine (0.6) MCPAK (0.6) diclofop + bromoxynil (0.8 + 0.3)	clopyralid (0.25) linuron + MCPA (0.3 + 0.55) 2,4-D amine (0.55) MCPAK (0.85) diclofop + bromoxynil (0.8 + 0.3) asulam + 2,4-DB (1.1 + 0.6) clopyralid + diclofop (0.25 + 0.7) difenzoquat + bromoxynil + MCPA (0.8 + 0.3 + 0.3)

On seedling stands of both legumes and grass species, tolerances observed in 1984 were similar to those noted in a similar experiment conducted in 1984. Variation from replicate to replicate within experiments was small at St. Claude but was fairly large at Oak Bluff, where parts of the trial had been water-logged due to heavy rainfall.

As noted in the 1983 Seedling Screening trials, a high proportion of treatment species combinations showed acceptable tolerance. Fifty percent of the herbicide/treatment combinations were acceptable in both years screens and at all sites within each years experiments.

In most cases, poor tolerances observed in seedling year did not cause noticeable reductions in growth the year after treatment. Exceptions to this occurred with chlorsulfuron treatments on seedling legumes or grasses, with metribuzin on seedling grasses and with sethoxydim on seedling grasses. In these cases, crop death occurred.

In trials at Manitou and Arborg, where the species when established the previous year were sprayed in 1984, a high number of treatments gave acceptable tolerance. Approximately 70% of established legume/herbicide combinations were acceptable. Variation in visual ratings from replicate to replicate within each site was low. Obvious differences in treatments from site to site occurred in some cases (eg. established bluegrass tolerance to broadleaf weed herbicides was generally lower at Arborg than at Manitou, asulam + 2,4-DB caused more injury on established legumes at Manitou than at Arborg). Ratings made on vegetative production were closely correlated with ratings made on production of heads in most cases, although exceptions occurred (eg. difenzoquat caused reductions of crop height in alfalfa but did not reduce flowering).

Differences between tolerance of seedling species to individual herbicides occurred at the genus level. Tolerance of creeping red fescue to diclofop was satisfactory, while tolerance of tall and meadow fescue to the same herbicide was poor. Tolerance of meadow fescue to dicamba was excellent, while tall and creeping red fescue showed reduced height due to dicamba application.

Promising treatments in alfalfa (seedling and established) included bromoxynil, metribuzin and bentazon as well as DPX Y6202, Dowco 453 and sethoxydim. Birdsfoot trefoil (established) showed good tolerance to all grasskillers but did not show satisfactory to any sprayed broadleaf weed herbicide at both sites. Similar results occurred with sweet clover. Also promising were most broadleaf weed herbicides in established grasses. Clopyralid, bentazon, 2,4-D, and MCPA did not cause unacceptable injury on any grasses.

Species which appear to limit weed control options due to unacceptable tolerance to herbicides include sweet clover and birdsfoot trefoil (established) (not tolerant to most broadleaf herbicides) and timothy (poor or marginal tolerance to all grasskillers applied in seedling stage of the crop).

Screens will be continued during 1985. Following this, further considerations might be given to examining possible effects on tolerance levels of companion cropping and species mixtures.

TOLERANCE OF ALFALFA FOR SEED TO 2,4-DB AND BROMOXYNIL

Ingrid Kristjanson, Manitoba Alfalfa Seed Producers' Association

Two problems prompted the Manitoba Alfalfa Seed Producers' Association to sponsor its summer research program -- lack of broadleaf herbicides registered for use in established alfalfa seed fields, and the inability to effectively control established sweet clover in alfalfa seed fields.

As the only post-emergent broadleaf treatment recommended for established alfalfa is the Asulox F/Embutox E tank mix, research included looking at alfalfa tolerance to 2,4-DB. Experiments involved studying increased rates, formulation comparisons, and time of application.

The second objective was to examine bromoxynil as a means of control for established sweet clover. Previous work on seedling sweet clover control looked promising, and both seedling and established alfalfa had shown good bromoxynil tolerance.

All experiments followed the randomized complete block design, with 4 replicates. Individual plots were 3m x 10m. All 2,4-DB treatments were applied with a spray volume of 200 l/ha.

One experiment to test the tolerance of alfalfa to 2,4-DB compared Embutox E, Cobutox, Butyrac 200 and Butyrac E, each at rates of 1.0 and 1.4 kg/ha. Crop height at time of spraying was 40 cm. All treatments resulted in epinasty and some degree of bloom delay. Ten days after spraying, Butyrac E at 1.4 kg/ha was visibly harder on the stand, with severe epinasty, leaf burn, height reduction of 15 cm, and bloom delayed by about 4 days. Embutox E at 1.4 kg/ha delayed 5 - 10 cm. Treatments at 1.0 kg/ha delayed bloom by about 1 day, with height reduction generally insignificant. Leaf burn occured in all the Butyrac E treatments. At second assessment 6 weeks after spraying, injury symptoms were largely outgrown,with the exception of height reduction. The following table illustrates the average visual injury ratings and seed yields.

Treatment	Rate (kg/ha	Visual Injury 10 days	Ratings (0-9) 6 weeks	Seed Yield (kg/ha)
Embutox E	1.0	7.1	7.5	716
Embutox E	1.4	6.3	7.4	683
Cobutox	1.0	7.0	7.9	685
Cobutox	1.4	6.5	7.8	631
Butyrac 200	1.0	7.4	8.3	684
Butyrac 200	1.4	7.5	8.0	661
Butyrac E	1.0	6.8	7.3	789
Butyrac E	1.4	6.3	7.0	767
Control	--	8.9	8.9	738
				(NSD)[1]

[1]No significant difference found using Duncan's Multiple Range Test (p = 0.05).

A second experiment comparing just Embutox E and Butyrac E showed similar results.

Treatment	Rate (kg/ha)	Visual Injury 10 days	Ratings (0-9) 6 weeks	Seed Yield (kg/ha)
Embutox E	1.0	6.8	7.9	601
Embutox E	1.4	6.1	7.3	427
Butyrac E	1.0	6.4	6.5	548
Butyrac E	1.4	5.0	6.0	510
Control (handweeded)	--	9.0	9.0	451
				(NSD)[1]

[1]No significant difference found using Duncan's Multiple Range Test ($p = 0.05$)

Tolerance of alfalfa to 2,4-DB formulations as affected by timing looked at spraying early morning, afternoon, and evening treatments of Embutox E and Butyrac E at 1.4 kg/ha. At the first rating, severe epinasty was seen in all treatments, with morning and afternoon applications harder on the crop than evening treatments. Butyrac E treatments caused more vegetative damage than Embutox E in all 3 timings. Afternoon treatments showed the best thistle control. Six weeks after treatment, most of the vegetative damage had been outgrown, particularly in the Embutox E treatments. We found no real differences in seed yields between the treatments. However, we feel that because the 2,4-DB treatments were applied quite late in the season, seed yields in all treatments may have been affected. For this reason any potential differences may have been lost.

Treatment	Time	Visual Injury 10 days	Ratings (0-9) 6 weeks	Seed Yield (kg/ha)[1]
Embutox E	morning	5.1	6.4	300 A
Butyrac E	morning	4.3	6.1	396 A
Embutox E	afternoon	6.3	6.9	354 A
Butyrac E	afternoon	6.1	6.3	417 A
Embutox E	evening	6.6	7.0	391 A
Butyrac E	evening	6.1	6.4	385 A
Control	--	9.0	9.0	592 B
Control (both hand weeded)	--	9.0	9.0	565 B

NOTE: Rate = 1.4 kg/ha

[1]Numbers followed by the same letter are not significantly different according to Duncan's Multiple Range Test ($p = 0.05$).

The second portion of the summer research tested bromoxynil as a control measure for established sweet clover. As stated before, previous work on seedling sweet clover control looked promising, with good tolerance seen in both seedling and established alfalfa.

Research included a comparison of 3 different bromoxynil formula-

tions currently available on the market, at 2 rates of application. We also looked at 4 different water volumes, each with 2 rates of bromoxynil application. Each experiment was conducted on both a pure sweet clover stand, and a sweet clover infested alfalfa field.

The variable water volume trial dealt with spray volumes of 100, 150, 200 and 250 l/ha. Bromoxynil at rates of .3 and .6 kg/ha were tested with each volume. Initial results were quite spectacular. Bromoxynil at .6 kg/ha in a spray volume of 100 l/ha resulted in excellent sweet clover control. As water volumes increased, sweet clover control decreased. At the highest water volumes, leaf material was browned off, while the plant stalks remained green. Although the higher water volumes increased plant coverage, the most concentrated spray droplets provided the best control.

Formulation trials compared Torch DS, Pardner and Bromox G 100 at rates of .3 and .6 kg/ha, and spray volume of 150 l/ha. Good control was seen in all treatments. Bromox C-100 at the high rate seemed to work better.

While Bromoxynil had a marked effect on sweet clover it did little to the alfalfa. Alfalfa tolerance was quite acceptable in all treatments. Initial ratings saw about 10% leaf burn which was largely outgrown by second assessment. The stand showed an overall height reduction of 15 cm. Alfalfa tolerance was good at all bromoxynil rates and water volumes. Initially sweet clover control was excellent. The majority of plants were completely burned off. However, regrowth began to occur from the root crown 3 weeks after spraying. Sweet clover control was much more effective when competition was provided by the alfalfa. Crown regrowth did occur, but the surviving plants were shorter and sparser than in the pure sweet clover stand.

Bromoxynil applications provided the added bonus of wild mustard control -- an important consideration as it is the sixth most reported weed by alfalfa seed producers. Injury to other weeds was noticed — including American dragonhead, night-flowering catchfly, and Canada thistle.

Competition provided by the alfalfa crop resulted in better sweet clover control and less vigorous crown regrowth in both experiments. This would seem to indicate that an early application of bromoxynil could effectively knock back established sweet clover, and competition from a good alfalfa stand would complete the control. Possibilities for future research could include split applications with the second application controlling any regrowth, as well as later germinating seedlings. A fall application controlling that year's seedlings could be followed by a second application in the spring. Another option involves yearly applications to control sweet clover seedlings, however later germinating seedlings wouldn't be controlled.

SUMMARY

In these trials, stressing the alfalfa seemed to increase seed yields, but there has been a lot of work to indicate that environmental conditions and time of application are critical factors in determining the extent of 2,4-DB injury or tolerance. Inspite of lack of conclusive evidence to show that bromoxynils will definitely control

sweet clover, we feel our results were encouraging enough to warrant further work. We feel that sweet clover control would be better if bromoxynils were applied early in the season, before reserves have a chance to build up. Other possibilites include split applications at one month intervals, and successive fall and spring applications.

ANNUAL CROPS FOR FORAGES

George Bonnefoy
Manitoba Department of Agriculture

At the 1980 annual meeting of the Manitoba Agronomists' Conference, a paper was presented by Dave Campbell on the importance and use of annual crops for forages. Annual crops can be used as supplementary pastures in summer or late fall during periods of drought when perennial pasture production is low, or they can be cut and stored as hay or silage for winter feed.

Although individual annual crops have been tested at the Research Stations and University almost continuously over the years, comparisons between crops are still not readily available.

In 1984, a few demonstration plots were seeded to compare crop performance under similar conditions (such as soil type, moisture, fertility, and weed control). One such trial was applied in the St. Claude area on an almassippi very fine sandy loam. The soil test analysis reported the following nutrients in the soil; nitrogen - 63 kg/ha; phosphorus - 8 kg/ha; potassium - 130 kg/ha; and sulphur 178 kg/ha. All crops were fertilized according to soil test recommendations (Table 1).

Table 1. Rates Of Fertilizer Applied & Method Of Application.

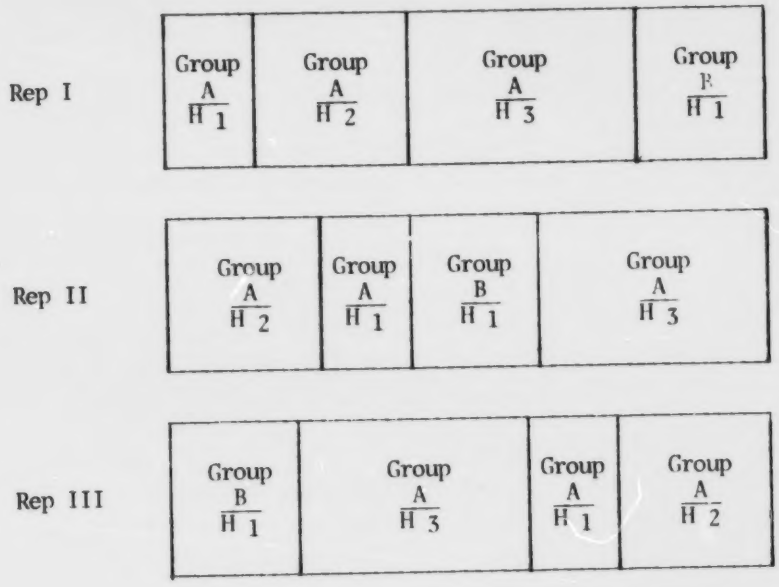
Crop	Nitrogen kg/ha	Phosphorus kg/ha	Potassium kg/ha
Wheat	60 B	45 B	50 B
Oats	60 B	45 B	50 B
Barley	60 B	45 B	50 B
Spring Rye	60 B	45 B	50 B
Fall Rye	60 B	45 B	50 B
Triticale	60 B	45 B	50 B
Sorghum/Sudan	60 B	45 B	50 B
Italian Ryegrass	60 B	45 B	50 B
Westerwold Ryegrass	60 B	45 B	50 B
Siberian Millet	60 B	45 B	50 B
Proso Millet	60 B	45 side band	50 B + 50 SB
Corn	60 B	45 side band	50 B + 25 SB
Sorghum	60 B	45 side band	50 B + 25 SB
Sunflowers	60 B	20 Drilled	50 B
Rapeseed	0	20 Drilled	50 B
Fababeans	0	45 B	50 B
Sweet Clover			

B - broadcast

SB - side band

D - drilled with the seed

The plot design was divided into four groups with the crops randomized within each group. Each plot was replicated 3 times.



A fertilized with nitrogen fertilizer
B inoculated legumes
H 1 Treflan applied pre-plant and incorporated
H 2 Buctril-M applied post-emergence
H 3 Buctril-M applied post-emergence

GROUP	CROP	VARIETY	SEEDING RATE kg/ha
A fertilizer H 1 Treflan	Rapeseed	Tobin	6
	Sunflowers	Cargill	45,000 plants/ha
A fertilizer H 2 Buctril-M	Wheat	Glenlea	100
	Barley	Bonanza	90
	Spring Rye	Gazelle	70
	Fall Rye	Cougar	70
	Triticale	Carman	130
	Sorghum/Sudan		20
	Corn	Pride R090	65,000 plants/ha
	Oats	Dumont	85
A fertilizer H 3 Buctril-M	Sorghum		7
	Italian Ryegrass	Lemtal	20
	Westerwold Rye	Aubade	20
	Siberian Millet		20
	Proso Millet		25

cont'd...

cont'd...

GROUP		CROP	VARIETY	SEEDING RATE kg/ha
B	inoculated	Fababeans	Ackerpearle	160
H I	Treflan	Peas	Century	165
		Sweet Clover	Norgold	11
		Red Clover	Ottawa	7

The crops were randomized within each group. Individual plots were 2.4 m X 15 m except for corn, sorghum and sunflowers which were 3.0 m X 15 m (4 rows @ 75 cm).

The plot was seeded on May 17th in a dry seedbed. Extensive damage was done to the plots which resulted in having to work and reseed replicate III on June 15th. Soil erosion damage to the small seedlings in Rep I and II made it necessary to exclude some of the data from this report. The following crops have been deleted; wheat, fall rye, fababeans, and red clover. Both sorghum and sunflowers were harvested but rotted in the bags before the dry matter weights were taken.

Yields were calculated by taking 3-½ m^2 samples in each replicate. Wet weights were taken, then dried, and sent to the Feed Testing Lab for analysis and dry matter determination. See Table.

Table 2. The Following Dry Matter Yields In kg/ha Were Obtained.

	DRY MATTER YIELDS kg/ha			
CROP	Rep I	Rep II	Rep III	Average
Barley	8767	9069	7256	8364
Oats	9674	6954	8163	8264
Spring Rye	8153	7860	3628	6547
Triticale	7558	6954	5140	6550
Rapeseed	4534	5139	4293	4655
Peas	8162	7860	7558	7860
Corn	8465	8464	8818	8582
Westerwold Ryegrass	4232	3930	3628	3930
Italian Ryegrass	4837	4925		4881*
Proso Millet	5139	6417	7860	6472
Siberian Millet	4534	7558	9311	7134
Sorghum/Sudan Hybrid	3628	4534	4214	4125

* Average of two replicates only.

The Crude Protein percentage of each crop was as determined by feed analysis.

Table 3. Crude Protein Percent.

CROP	Rep I	Rep II	Rep III	Average
Barley	11.1	13.0	9.2	11.1
Oats	12.2	9.6	9.5	10.4
Spring Rye	9.2	9.7	9.2	9.4
Triticale	10.7	10.9	9.0	10.2
Rapeseed	19.3	21.8	10.0	17.4
Peas	20.9	19.5	16.7	19.0
Corn	13.0	13.6	14.2	13.6
Westerwold Ryegrass	16.7	18.4	15.6	16.9
Italian Ryegrass	15.6	14.5		15.1*
Proso Millet	11.6	14.1	12.9	12.9
Siberian Millet	11.9	9.2	11.0	10.7
Sorghum/Sudangrass	13.7	13.4	10.2	12.4

* Average of two reps.

The estimated TDN percentage of each crop was as follows:

Table 4. Estimated T.D.N. Percent.

CROP	Rep I	Rep II	Rep III	Average
Barley	58.0	56.2	52.0	55.4
Oats	58.3	52.2	53.3	54.6
Spring Rye	55.4	52.2	49.8	52.5
Triticale	53.7	52.5	51.5	52.6
Rapeseed	64.2	61.4	50.0	58.5
Peas	54.0	54.8	61.2	56.4
Corn	63.4	62.1	56.2	60.6
Westerwold Ryegrass	58.2	57.4	53.8	56.5
Italian Ryegrass	56.1	63.8		60.0*
Proso Millet	56.9	57.5	56.6	57.0
Siberian Millet	54.0	53.0	56.0	54.3
Sorghum/Sudangrass	56.7	56.4	53.8	55.6

* Average of 2 reps.

Table 5. A summary table averaging the dry matter production, the crude protein percentage, and the estimated total digestable nutrient percentage of 3 replicates.

CROP	DM kg/ha	Crude Protein Percent	Estimated TDN %
Barley	8364	11.1	55.4
Oats	8264	10.4	54.6
Spring Rye	6547	9.4	52.5
Triticale	6550	10.2	52.6
Rapeseed	4655	17.4	58.5
Peas	7860	19.0	56.4
Corn	8582	13.6	60.6
Westerwold Ryegrass	3930	16.9	56.5
Italian Ryegrass	4881	15.1	60.0
Proso Millet	6472	12.9	57.0
Siberian Millet	7134	10.7	54.3
Sorghum/Sudangrass	4125	12.4	55.6

Since the data presented is the result of only one year's test, no definite conclusions can be made.

A similar plot was seeded on May 22nd in the Holland area (SE22-8-11W) on a Stockton fine sandy loam soil. The soil was sampled and the fertilizer was applied as recommended by soil analysis.

Treflan was applied pre-plant and incorporated in the following plots; rapeseed, sunflowers, sweet clover, and alfalfa.

HERBICIDE	CROP	FERTILIZER (kg/ha)
Treflan	Rapeseed	N = 75 P = 20 S = 20
	Sunflowers	N = 75 P = 40 S = 20 K = 60SB
	Sweet Clover	N = 17 P = 35 S = 20
	Alfalfa	N = 17 P = 35 S = 20
Hoegrass + Buctril-M	Wheat	N = 75 P = 35 S = 20
	Barley	N = 75 P = 35 S = 20
	Triticale	N = 75 P = 35 S = 20
	Fall Rye	N = 75 P = 35 S = 20
	Spring Rye	N = 75 P = 35 S = 20
Stampede	Corn	N = 75 P = 40 S = 20 K = 60SB
	Sorghum/Sudangrass	N = 75 P = 35 S = 20
	Oats	N = 75 P = 35 S = 20
None	Siberian Millet	N = 75 P = 35 S = 20

The treatments were replicated three times. Meter square samples were taken for yield and dry matter determination.

Table 6.

CROP	Crude Protein Percent	Estimated TDN %	Yield kg/ha
Oats	10.7	62.8	4080
Wheat	11.1	62.6	3968
Barley	9.5	64.9	5762
Triticale	9.4	63.7	5134
Fall Rye	21.8	62.2	1502
Spring Rye	8.4	58.9	4574
Siberian Millet	10.5	59.5	7443
Sorghum/Sudangrass	10.4	59.9	3385
Corn	8.4	66.0	7488
Sunflowers	11.7	57.0	5964
Sweet Clover	16.5	65.0	5426
Alfalfa	17.9	67.0	2758

For further information contact Mr. Vaughan Greenslade, Grassland Specialist, Portage la Prairie, Manitoba.

An annual forage demonstration was seeded in the Lundar area (SE23-20-5W) on May 14th, 1984. The fertilizer was applied broadcast at the following rates; nitrogen - 64 kg/ha; phosphorus - 330 kg/ha. The varieties were harvested according to stage of maturity.

Table 7.

CROP	DM Yield kg/ha	Crude Protein Percent	Estimated TDN %	Date Of Harvest
Annual Ryegrass	5000	8.9	56.6	July 18
Siberian Millet	6860	11.0	58.1	July 26
Proso Millet	6614	8.0	60.0	July 26
Oats (Dumont)	9350	10.3	65.2	Aug. 8
Triticale (Carman)	9461	9.2	64.2	Aug. 8
Fababean (Ackerpearle)	4619*	13.5	63.3	Aug. 16
Sorghum/Sudangrass	9932	6.5	58.4	Aug. 16

* very poor germination

For further information, contact Gerry Breakey, Grassland Specialist, Ashern, Manitoba.

Three annual and biennial demonstrations were applied in the following areas. Yield comparisons can be made within plots but not between sites.

Table 8. Seven Sisters Area (NW12-13-10E).

CROP	Yield D.M. kg/ha	Crude Protein Percent
Dwarf Rape	2113	10.9
Annual Ryegrass	2531	12.8
Proso Millet	3623	14.2
Siberian Millet	3368	12.4
Sorghum/Sudangrass	5571	9.6
Jerusalem Artichoke	6080	12.7
Triticale	7740	10.0
Barley	5186	10.8
Oats	4244	8.8
Fababeans*	1861	20.2
Sweet Clover	2547	19.5

* Insect damage.

Table 9. Dugald Area (NE18-10-6E).

CROP	Yield D.M. kg/ha	Crude Protein Percent
Dwarf Rape	2331	12.4
Annual Ryegrass	5034	6.1
Proso Millet	4076	8.2
Siberian Millet	5300	7.8
Sorghum/Sudangrass	6691	7.1
Jerusalem Artichoke	6676	10.8
Triticale	6262	7.3
Barley	7412	7.5
Oats	7046	7.7
Fababeans*	2934	15.1
Sweet Clover	4258	19.3

* Insect damage.

Table 10. Dufresne Area (SW31-9-6E).

CROP	Yield D.M. kg/ha	Crude Protein Percent
Dwarf Rape	6866	16.3
Annual Ryegrass	7145	10.6
Siberian Millet	3279	13.1
Sorghum/Sudangrass	4197	14.0
Jerusalem Artichoke	5754	13.1
Triticale	8614	12.3
Barley	6165	9.3
Oats	5778	10.8
Fababeans*	1574	21.9
Corn	5931	11.8

* Insect damage.

For further information, contact Fraser Stewart, Grassland Specialist, Beausejour, Manitoba.

An annual forage test was also conducted at Lake Audy & Brandon Research Station in 1984. For further information, contact Richard Simon, Forage Research, Brandon Research Station.

Table 11. 1984 Annual Forage Test.

	Lake Audy			Brandon		
Entry	Date Cut	Yield kg/ha	% DM	Date Cut	Yield kg/ha	% DM
Oats						
OA330-60	Aug 22	2892	54.3	Jul 26	1093	45.4
Sentinel	Aug 22	2661	54.8	Jul 26	1661	49.2
Foothill	Aug 16	2720	58.9	Jul 26	2026	53.1
Fraser	Aug 2	2447	52.8	Jul 26	1616	47.8
Laurent	Aug 16	3545	52.5	Jul 26	1619	49.4
2088-524	Aug 16	2778	51.9	Jul 26	1641	46.5
Barley						
Johnston	Aug 2	4004	58.5	Jul 20	2416	50.7
Halton	Aug 9	3933	54.2	Jul 26	1873	50.3
Wheat						
Pitic	Aug 9	1895	66.1	Jul 26	2063	59.7

cont'd...

Table 11. Continued...

Entry	Lake Audy Date Cut	Lake Audy Yield kg/ha	Lake Audy % DM	Brandon Date Cut	Brandon Yield kg/ha	Brandon % DM
Triticale						
Triwell	Sep 10	2277	64.6	Aug 1	1888	65.7
773	Aug 22	1945	49.5	Aug 7	2026	59.7
75L005	Sep 10	2038	58.7	Aug 1	1776	63.3
Others						
Tara peas	Aug 9	2422	28.5	Jul 20	2022	33.7
Fababean	Aug 16	1378	22.3	*	*	*
Sunflower	Aug 22	2407	27.1	Aug 28	501	33.7
Corn	Aug 16	716	21.2	Aug 28	938	41.8
Mean		2504	48.5		1725	49.4
SE		226	2.6		133	1.8

*Fababeans at Brandon were badly damaged by grasshoppers and blister beetles.

SUMMARY (Of All Trials)

	T.D.N. kg/ha	T.D.N. Rank	D.M. Yield/ha Rank	Crude Protein/ha Rank
Corn	3609	1	7	3
Barley	3579	2	1	8
Oats	3489	3	5	10
Triticale	3474	4	3	9
Siberian Millet	3342	5	6	15
Spring Rye	3275	6	4	13
Proso Millet	3250	7	8	5
Peas	3161	8	9	1

I have ranked the first 8 crops according to T.D.N. production per hectare starting from corn and ending with peas. The second column gives the ranking in terms of the dry matter yield per hectare and the last column to the right is the ranking of the crude protein per hectare. I have only done this for 8 out of the 19 crops.

We hope to continue this demonstration in 1985.

NEW MANITOBA CROP INSURANCE FORAGE PROGRAMS

Brian E. Halstead
The Manitoba Crop Insurance Corporation
Portage la Prairie, Manitoba

I don't want to get into a discussion on how to establish a forage crop or variety or fertilizer recommendations for an established stand. I'll leave that up to the departmental forage, grassland and livestock specialists and others from the university Ag. Canada staff, and private industry.

For starters, what I would like to do is throw out a few figures to emphasize the importance of forage in Manitoba economy. There were over one million total cattle on farms on July 1, 1984. There are over 500 thousand hectares of tame hay harvested in the province yearly, and over 350 thousand hectares of pasture, and many hundreds of thousands of hectares of native hay and annual cereals and other crops cut for livestock feed. Add to this our 30,000 hectares of silage corn and 25,000 hectares of pedigree forage seed. All of these adding up to a value of several hundred million dollars. If you add on the value of the cattle in the industry which depends very directly on the forage supply, you have close to a billion dollar plus industry.

Of course there are other factors besides the use of forages as a livestock food for the cattle of the province which make forages a vital part of the agriculture industry. Forages can be grown strictly as a cash crop to be marketed either inside or outside the province. As fuel costs rise, reducing the amount of energy used to produce a crop becomes more important. Besides energy conservation, we should also be concerned with the use of forage in the area of soil conservation and land management.

With more and more acres of forages grown as a cash crop or to support a livestock enterprise, there is a growing need to protect the producers growing these crops from the impact of natural disasters and resulting feed or seed shortages.

The following are some of the situations which you could get into as a forage grower:

(1) growing alfalfa grass mixtures for hay production and the hay yields are below normal because of excess moisture.
(2) establishing a forage crop - you don't get a good "catch" and the new seeding does not develop into a good hay crop.
(3) short of hay for your herd - hay has gone up to $80 per tonne because of reduced supply in the area.
(4) growing a crop of Timothy for pedigree seed production - yield reduced due to severe drought.
(5) growing alfalfa for seed production and severe winter kill drastically reduced your yield.
(6) grasshoppers wipe out your oats sown for annual forage production.

Figure 1 illustrates the history of M.C.I.C. forage programs over the years, from the first year that All-risk Forage Insurance was made available to the future when we hope to bring on more forage crops. Today I would like to briefly go over each of the current, new and future forage programs.

All-risk Forage Insurance

Forages grown as a cash crop or to support a livestock enterprise are protected against the impact of natural hazards. Coverage is available for pure alfalfa stands, alfalfa-grass mixture, grasses and sweet clover. Payouts are calculated by comparing the farmer's individual yields to a long term average yield.

Forage Establishment Option

Coverage is available for cultivated forage crops during the time the crop is being established. The farmer may not get a good catch of his new forage planting and the new seeding may not develop into a good hay crop. This program is an optional program as a sort of endorsement to the regular forage insurance available for a small additional premium.

Livestock Feed Security Program

This program was new in 1984 and offered in seven rural municipalities on a test basis. There were 385 livestock producers on the program with an average coverage of $179 per cow. A total of over one million dollars was paid out in indemnities in 1984. The program will be expanded to include an additional 15 R.M.'s and L.G.D.'s in 1985. This is an area based program, the area being the R.M. or L.G.D. An average historical yield has been established for each R.M. or L.G.D. based on the yields of alfalfa, alfalfa-grass mixtures and grasses in the area. Each year forage yields are calculated from representative livestock producers within the areas and these yields are compared to the long term average yield. A payout is made to all producers who have opted into the plan if the year's average forage yield in the whole R.M. or L.G.D. is below 70% of the long term average yield. This pooling of risk has meant some inequities in some R.M.'s in 1984. If the average production is above 70% in an area, some producers in isolated areas may experience a severe shortage. However, this must be weighed against the fact that the spreading of the risk over many producers in the area keeps the rates much lower. Premiums collected from the producers and the federal government, who pays half the total premium, are used to establish a fund to be sure that there is money for payouts in years of shortages of hay in an area.

Premiums are collected based on the number of cows that a livestock producer intends to overwinter. Coverage levels are available from $60 per cow to $220 per cow in $20 increments. The livestock producer can select the dollar coverage per cow which best reflects the average cost of forage requirements for his cow herd. The farmer's premium rate for 1985 will be 3.67% of the coverage selected.

March 31, 1985 will be the final date for applying for coverage under the Livestock Feed Security Program for the 1985 crop year.

Pedigree Timothy Seed Production

1985 will be the first year that M.C.I.C. will offer insurance protection on a forage for seed production. We feel that the production of forage seed and in particular pedigree forage seed production, is a valuable part of the total provincial forage program and hope to provide insurance on other forage seed crops in the future.

For 1985, coverage will be available on 1 to 5 year old stands of Timothy with year one being the first seed producing year following establishment. We will also be providing coverages for pedigree Timothy seed losses during the establishment year. For a small additional premium the Timothy grown for pedigree seed production can be protected against failure to establish during the seedling year. Hail protection will also be available under the Hail Spot Loss Option or by buying additional hail coverage under Part II of The Crop Insurance Act.

What about future crop insurance programs for forage producers? We have started work on a pedigree alfalfa seed program. This program is still in the initial planning stages and is on our timetable for the introduction of new crops for 1986. We are also looking at a program to provide protection for producers growing annual cereals for forage production. As George Bonnefoy mentioned in his talk yesterday, there are many annual crops which can be used as a source of forage. Also in the future, we will be expanding the Livestock Feed Security Program to eventually provide this program in all R.M.'s and L.G.D.'s in the province. At the same time, we will be looking at reducing somewhat the unit used as an area to measure production from a whole R.M. or L.G.D. down to as small an area as a township or smaller.

In summary, The Manitoba Crop Insurance Corporation looks forward to further expansion of the program and to continue providing financial protection to both existing and future forage crops grown in Manitoba.

FIGURE 1

MANITOBA FORAGE CROPS

FORAGE CROP	AREA	VALUE
Tame Hay	500,000 ha	$130 million
Pasture	350,000 ha	$ 50 million
Annual Cereals	?	?
Silage Corn	30,000 ha	$ 9 million
Native Hay	?	?
Pedigree Forage Seed	25,000 ha	$ 5 million
Total Cattle Numbers	1 million	
Total Cattle Value	$600 million	

MANITOBA

HEAD SMUT OF CORN

Spacelotheca reiliana

This disease was first identified in Ontario in 1979. In 1980, the presence of the disease was confirmed in approximately 100 fields across Ontario. Head smut is potentially a much more serious disease than common, because of its ability to survive in the soil for several years. Under favorable conditions for disease development, succeeding corn crops for several years can be infected.

While head smut has occurred most often on clay and clay loam soil, it has attacked corn on lighter soils as well. Corn under stress during germination and emergence appears to be more susceptible to infection. Headlands compacted by machinery, and wet areas of fields have shown higher levels of infection. Often late planted corn has also been infected at a higher level.

The head smut fungus enters the seedling corn plant only during seed germination and seedling emergence. Symptoms of the disease are not evident until development of ears and tassels. In infected plants, the cob is usually replaced by a mass of spores, enclosed completely by the husks. Only rarely is any grain present in an infected ear. Infected ears are not easily detected until maturity, because husks cover the spore mass. However, such ears are usually shorter, swollen and spongy when grasped and have no silks. Occasionally, infected plants produce several smaller ears, all at the same node, or at three or four nodes on the corn plant.

Presence of the disease in the plant can also affect the tassel. The infected tassels look like black tar brushes. Plants with smutted tassels may be severely dwarfed. Since infected tassels are much more prominent than infected cobs, this is usually the first detected symptom of head smut. Where the tassel is infected by head smut, the ear will also be infected. However, other plants in the field will show infected ears without infected tassels.

It should be noted that the same corn plants can be attacked by both head and common smut. In this case, head smut masses will occur in the ear and perhaps also on the tassel; while common smut masses may appear on the stalk or leaf.

Head smut spores overwinter in the soil and attack the corn in the spring during the seedling stage. Spores can survive in soil for several years, and may attack corn seedlings over this period of time. The fungus grows systematically within the corn plant, affecting the developing ears, and frequently the tassel. The spore masses in the ear and tassel mature in late summer and fall and drop to the ground, increasing the spore numbers available to infect corn seedlings the following spring. Spores can be carried from farm to farm on any contaminated equipment,such as combines, forage

harvesters and tillage equipment. Seed corn which has surface contamination of spores has also been a source of spread of this disease.

On farms where head smut has been identified, selection of corn hybrids with resistance to this disease should be considered.

The fungicide Vitaflo 280 is registered for use on corn and is effective for control of seed-borne head smut spores. This fungicide will give only partial protection from this disease where susceptible hybrids are planted in infested soil.

Where head smut has shown up on only one field, steps can be taken to reduce spread to other fields. Since harvesting equipment will carry spores into a disease-free field, infested fields should be harvested last. Equipment should be washed as thoroughly as possible with high pressure water.

Smut spores are not toxic to livestock. Corn silage or grain containing head smut spores can be fed to livestock quite safely. It is known that viable spores can pass through livestock. Therefore, it is possible that this disease could be spread in livestock manure.

Plant Health was brought into survey action due to phytosanitary standards and the export trade in 1980. At that time we were only interested in seed fields. I believe that the survey was carried out too early to bring about detection results. Therefore, we concluded, probably incorrectly, that the Head Smut of corn did not occur in Manitoba. Because of this we did no survey for this disease in 1981 or 1982.

In August of 1984, a suspicious sample was submitted to Dr. Gary Platford and was identified. Because of other duties, Plant Health did an initial survey to detect this disease and determined its presence to the west and south of Winnipeg. No further effect was attempted until 1984.

In September and October, 1984, Plant Health staff further surveyed for this disease. Twenty-four municipalities were chosen for the survey. All these municipalities were west of the Red River.

In all one hundred and ninety-three (193) fields of corn were surveyed for a total of twenty-one thousand and forty-eight (21,048) acres. Of this amount, one hundred and fifty-one (151) with an acreage of thirteen thousand, nine hundred and ninety-one (13,991) were found to be free of the disease. However, forty-two (42) of the fields of seven thousand and fifty-seven (7,057) acres were found contaminated to varying degrees. These degrees were: Trace - 29 fields; 1%-5% - 9 fields; 6%-10% - 2 fields and 11%-50% - 2 fields.

Fifteen municipalities were found infected with the disease in varying degrees. This was in fifteen of twenty-four municipalities surveyed. Fields of feed and silage corn were surveyed, but the disease was found in two (2) acres of Sweet Corn as well. The survey

showed that of the area surveyed, a little over one-fifth of the fields suffered from the Head Smut of Corn, Spaceotheca reiliana.

It is difficult to determine in what manner the disease was transferred to Manitoba, but 70% of the seed corn planted in Ontario comes west into the Prairies. We do not know how long the disease has been in Manitoba, but the general consensus seems to be that it has been here for at least four years.

Sources: Head Smut of Corn - C.L. Hunter & W.C. Wright, Revision of Factsheet "Head Smut of Corn", January, 1981.

MUNICIPALITY	TOTAL SURVEY		NEGATIVE REPORTS		POSITIVE REPORTS		INTENSITY PERCENT			
	Fields	Acreage	Fields	Acreage	Fields	Acreage	Trace	1-5%	6-10%	11-50%
Lansdowne	3	176	3	176	-	-	-	-	-	-
Langford	10	695	6	375	4	320	2	1	-	1
Westbourne	10	740	9	540	1	200	1	-	-	-
Elton	3	400	2	360	1	40	1	-	-	-
North Cypress	9	496	5	310	4	186	4	-	-	-
North Norfolk	19	1585	18	1540	1	45	1	-	-	-
Portage la Prairie	13	2351	10	1065	3	1286	1	2	-	-
Cornwallis	8	1840	3	690	5	1150	2	2	-	1
South Cypress	4	400	1	160	3	240	2	1	-	-
Victoria	2	260	1	60	1	200	-	-	1	-
South Norfolk	5	1300	2	340	3	960	2	1	-	-
Grey	12	1200	11	800	1	400	1	-	-	-
Dufferin	20	1760	18	1605	2	155	2	-	-	-
Argyle	6	400	6	400	-	-	-	-	-	-
Lorne	1	90	1	90	-	-	-	-	-	-
Thompson	11	1500	6	590	5	910	3	1	1	-
Roland	10	920	7	620	3	300	3	-	-	-
Morris	1	320	1	320	-	-	-	-	-	-
Roblin	5	405	5	405	-	-	-	-	-	-
Louise	7	750	7	750	-	-	-	-	-	-
Pembina	4	290	4	290	-	-	-	-	-	-
Stanley	14	1380	9	715	5	665	4	1	-	-
Rhineland	9	1030	9	1030	-	-	-	-	-	-
Montcalm	7	760	7	760	-	-	-	-	-	-
TOTALS	193	21048	151	13991	42	7057	29	9	2	2

DISEASES OF WILDRICE

David Punter, Department of Botany, University of Manitoba

Although wildrice has been harvested from the wild by north-American Indians for many centuries, it is relatively new as an agricultural crop. Significant efforts at cultivation have only been made during the past 15 years, principally in Minnesota, where some 10,000 ha are now developed for paddy production, and more recently in California where the crop is expanding rapidly.

Prior to cultivation little was known of the diseases of wildrice beyond occasional accounts of famine among native people linked to failure of the natural crop from outbreaks of ergot. The recognition and study of wildrice diseases has gone hand in hand with the increase in paddy acreage since disease control is both more economically justifiable and more feasible under cultivation than in the wild. Most wildrice production in Manitoba is still from natural stands and thanks to the efforts of McQueen (1981) we now have a good idea of the range and distribution of diseases in our lake stands.

Brown spot symptoms are more prominent and damaging at southerly locations while anthracnose appears to be more significant at higher latitudes. For reasons which are not entirely clear, the organisms which cause brown spot and stem rot are generally more widespread and abundant in paddies than in natural stands whereas the reverse is true of anthracnose, leaf blotch and ergot. Notwithstanding this general knowledge of disease occurrence, we still have no reliable way to translate levels of symptom expression into yield reduction values.

Farmers in southern Manitoba who have access to sufficiently reliable water supplies and some otherwise unproductive land may wish to consider growing wildrice. The semi-aquatic habit of the plant is a feature shared with white rice but one which sets it apart from our common cereals and most other grasses. It is also unique in having three distinct phases of vegetative growth prior to flowering - the submerged, floating, and aerial leaf stages. Of these, the latter two are more susceptible to disease than the first. Despite these differences, many wildrice pathogens are also found on other grasses, especially aquatic ones, and on dryland cereals. A listing of the principal diseases, with causal pathogens, their approximate host ranges and distributions is given in Table 1.

Clearly there is a potential danger in planting wildrice close to some other crops and in allowing certain weeds, especially aquatic grasses, to grow in or alongside paddies. Unfortunately, little or nothing is known of the specificity of strains or pathovars of most of these pathogens from wildrice with respect to other hosts or vice versa. Therefore it is not possible at present to quantify the risk or to make definite recommendations as to distances by which paddies should be separated from cereal fields. However, as chemical control measures are not freely available for this crop, these pathological considerations should not be ignored when siting and managing paddies.

Sources:

Anonymous. 1960. Index of plant diseases in the United States. U.S. Dep.Agric., Handbook No. 165. 531 pp.

Berger, P.H., Percich, J.A., Ransom, J.K. 1981. Wheat streak mosaic in wild rice. Plant Disease 65: 695-696.

Bowden, R.L., Percich, J.A. 1983a. Bacterial brown spot of wild rice. Plant Disease 67: 941-943.

Bowden, R.L., Percich, J.A. 1983b. Etiology of bacterial leaf streak of wild rice. Phytopathology 73: 640-645.

DISEASES OF WILDRICE

Disease	Causal organism(s)	Reported in Lakes	Reported in Paddies	Range Manitoba	Range Elsewhere	Other Susceptible Hosts
Brown spot	*Cochliobolus miyabeanus* *	+	+	+	+	Rice (? other grasses)
	C. sativus *	+	+	+	+	Most cereals & wild grasses
	Fusarium spp. *	+	+	+	+	Many cereals & wild grasses
	Pseudomonas syringae pv. *syringae*	+	+	-	+	Corn, wheat
Anthracnose	*Colletotrichum* sp.	+	+	+	+	Various cereals & grasses
Leaf blotch	*Phaeoseptoria* sp.	+	+	+	+	? Many grasses
Zonate eyespot	*Drechslera gigantea*	+	+	-	+	Smooth brome, reed canary, quack
Leaf streak	*Xanthomonas campestris* pv. *translucens*	+	+	-	+	Wheat, smooth brome, barley
	X. campestris pv. *cerealis*	+	+	-	+	Wheat, quackgrass, barley
	Ps. syringae pv. *zizaniae*	+	+	-	+	Rye, smooth brome, quack, timothy.
Wheat streak mosaic	Wheat streak mosaic virus	-	+	-	+	Wheat, barley, oats, corn
Stem/sheath rot	*Sclerotium oryzae* #	+	+	+	+	Rice, some aquatic grasses
	S. hydrophilum #	+	+	+	+	Rice, aquatic grasses & broad-leaf weeds, e.g. water-lilies, water plantain.
Smut (stem/leaf)	*Entyloma lineatum*	+	+	+	+	? Rice
Ergot	*Claviceps zizaniae*	+	-	+	+	None

*May also cause stem/sheath rot
#May also cause leaf spotting

Bowden, R.L., Kardin, M.K., Percich, J.A., Nickelson, L.J. 1984. Anthracnose of wild rice. Plant Disease 68: 68-69.

Gilbert, P.F. 1974. A preliminary study of fungi associated with diseases of wild rice in Manitoba. M.Sc. Thesis, University of Manitoba, 258 pp.

Kardin, M.K., Bowden, R.L., Percich, J.A., Nickelson, L.J. 1982. Zonate eyespot of wild rice caused by Drechslera gigantea. Plant Disease 66: 737-739.

McQueen, D.A.Ross. 1981. A survey of the diseases of wild rice in Manitoba. M.Sc. Thesis, University of Manitoba, 90 pp.

Pantidou, M.E. 1959. Claviceps from Zizania. Can.J.Bot. 37: 1233-1236.

Punter, D., Reid, J., Hopkin, A.A. 1984. Notes on sclerotium-forming fungi from Zizania aquatica (wildrice) and other hosts. Mycologia 76: 722-732.

HERBICIDE/HERBICIDE, HERBICIDE/ADJUVANT, AND HERBICIDE/INSECTICIDE MIXTURES

Paul N.P. Chow
Agriculture Canada Research Station, Brandon, Manitoba

I. Herbicide/Herbicide Mixtures

Weed populations are biodynamic in their competition with other species in the plant kingdom. Their keen competition for moisture, nutrients, and light promotes their survival. When one type of weed is eliminated, another type will often invade the same space. Evidence indicates that most, if not all, herbicides are so specific in their action on target plants that no single herbicide can control all the weeds in a field. For example, in studies Poast at 0.3 kg/ha gave excellent control of wild oats, but did not control broadleaf weeds such as common lamb's-quarters and redroot pigweed (Table 1). The control of wild oats by Poast actually provided space for broadleaf weeds to grow better and produce more seeds.

Table 1. Mixtures with Poast for weed control (Field experiments, average of 1979/81)

Treatment (kg/ha)	Seed Produced, (g/m^2)		
	Wild Oats	Broadleaf	Flax
Untreated check	10.0	21.6	27.0
Handweeded check	0.2	2.1	139.5
Poast, 0.3	0.5	75.2	94.5
Poast + Buctril-M, 0.3 + 0.6	1.0	3.4	143.0
Poast + MCPA amine, 0.3 + 0.6	1.0	2.6	132.5
Poast + MCPA K, 0.3 + 0.6	2.2	4.4	130.0
Poast + Stampede, 0.3 + 0.6	1.5	1.3*	142.0

* 1979 only

Consequently, Poast did not produce a maximum flax as did the handweeded check. However, when Poast was mixed with each of four broadleaf weed herbicides (Buctril-M, MCPA amine, MCPA K, and Stampede), broadleaf weed control improved considerably. By controlling both weed types, flax seed yields with Poast mixtures were substantially

higher than with Poast alone or the untreated check, and were equal to those of the handweeded plots. Obviously, there are two main reasons for herbicide mixtures: (1) the grower can obtain a broad spectrum of weed control unavailable with a single herbicide, and (2) the grower can avoid repeated trips across the field, thereby saving time and money. Herbicide mixtures have become more popular and acceptable to both the chemical industry and the grower over the last two decades. In 1968, when I joined the Brandon Research Station as a research scientist, only a few herbicide mixtures such as Kil-Mor (dicamba/2,4-D/mecoprop), Buctril-M, and Brominal M (bromoxynil octanoate/MCPA) were on the market. However, this situation has changed dramatically. In 1976, only 16 herbicide mixtures of 75 different herbicides were registered in Manitoba. (No figures are presented in Manitoba Agriculture's Guide to Chemical Weed Control prior to 1975). But in 1984, 47 herbicide mixtures of 166 herbicides were available (Table 2).

Table 2. Registered herbicides and their mixtures in Manitoba

Herbicides or mixtures	1976	1984
Total no. of herbicides	75	166
Herbicide mixtures	16	47
% of herbicide mixtures	21.3	28.3

Sources: 1975 and 1984 Guide to Chemical Weed Control, Manitoba Agriculture

In recent years, every new herbicide is requested to test in mixture with other types of herbicide. Thus, more herbicide mixtures may be added to the market each year. For example, Hoe-Grass can now be combined with Pardner, Torch, Torch DS, and Hoe Grass II (a pre-mixture). Avenge 200 C can be mixed with 9 broadleaf weed herbicides (Buctril-M, Bromox 450M, Sabre, MCPA ester, 2,4-D ester, Pardner, Torch, and Torch DS).

Table 3. Herbicide and herbicide mixtures registered for various crops in Manitoba

Herbicides or mixtures	1984					
	Barley	Wheat	Corn	Flax	Canola	Horticultural crops
Total no. of herbicides	59	56	26	38	10	50
% of herbicide mixtures	72.9	71.4	57.7	44.7	0	22.0

Sources: Tables 1-5 and 7 in 1984 Guide to Chemical Weed Control, Agdex 641, Manitoba Agriculture.

Apparently, there are a great number of herbicide mixtures now available for barley, wheat, corn, and flax; fewer for horticultural crops; and none for canola (Table 3). More research in herbicide mixtures for canola is urgently needed. The recent development of triazine-resistant canola is promising for the use of broadleaf weed herbicides in mixture with grass herbicides.

II. Herbicide/Adjuvant Mixtures

Herbicides in their pure chemical form are practically useless to growers. To make them convenient and economic to apply, herbicides are formulated with appropriate solvents, diluents, emulsifiers, or surfactants. All these additives are called "adjuvants". To enhance herbicide activity for better weed control, most researchers are investigating two types of adjuvants: surfactants and inorganic salts. The non-ionic surfactant group (i.e., a surfactant having no charge and remaining chemically inert) is most commonly used with herbicides and other pesticides for several reasons: (1) better compatibility with other types of surfactants, solvents, and water, (2) resistance to hard water, and (3) effectiveness in decreasing surface tension on leaves.

There are about 200 non-ionic surfactants on the market. Their activity or ability to enhance herbicides varies considerably. This variation is even more when mixed with different types of herbicides.

Based on investigations last winter of 20 herbicides with more than 10 non-ionic surfactants at the Brandon Research Station, three facts became clear: (1) on a percent basis, 79% of commercial herbicides and 86% of new herbicides can be improved for better weed control by adding one or two surfactants (Table 4).

Table 4. Response of herbicides to added non-ionic surfactants

Response	Herbicides (%)			All Surfactants (%)
	Commercial	New	All	
Effective	79	86	85	57

(2) Not all non-ionic surfactants added to the herbicides showed the same response. Only 57% of surfactants tested effectively boost the activity of herbicides (Table 4). Four broadleaf weed herbicides and four wild oat herbicides in combination with various surfactants showed different responses: positive, negative, or no response depending on which herbicides and surfactants were mixed (Table 5). Therefore, users should be aware of the unpredictable relationship between herbicides and surfactants. Addition of an inappropriate surfactant to herbicides could translate into dollar losses.

Table 5. Response of non-ionic surfactants added to herbicides

Herbicide	No. of non-ionic surfactants tested	Test plant	Response to surfactants (% of fresh wt.)		
			+	-	0
2,4-D	7	Canola	7 (38-69 vs 93%*)		
MCPA amine	7	Canola	3 (12-23 vs 36%)		
Buctril-M	8	Canola		1 (39 vs 23%)	7
Blagal	8	Canola		4 (59-69 vs 49%)	4
Carbyne	7	W. oats	7 (15-42 vs 51%)		
AC-222,293	9	W. oats	9 (15-20 vs 34%)		
Dowco 453	10	W. oats	10 (23-76 vs 101%)		
DPX Y6202	8	W. oats	6 (51-77 vs 89%)	2 (96-100 vs 89%)	

* The values underlined indicate the herbicide applied without added surfactants.

(3) Several inorganic salts added to herbicides also increase the activity of some chemicals and improve weed control, but not in all cases. It was found that to boost herbicidal activity, it is necessary to add both a salt as well as an appropriate surfactant. For example, without combining Renex-36 with ammonium sulfate at 0.5 to 2.5% (w/v), the addition of ammonium sulfate at higher concentrations (0.5 to 2.5%) reduced wild oat control by Poast (0.1 kg/ha). When the concentration of Renex-36 increased from 0.1 to 2.5%, the antagonistic effect of ammonium sulfate on Poast was reduced. Overall, the combination of 0.5% ammonium sulfate and 0.5% Renex-36 with Poast (0.1 kg/ha) gave the maximum wild oat control.

III. Herbicide/Insecticide Mixtures

Wild oats, Canada thistle, and flea beetles are three major pests threatening canola yields in the Canadian Prairies. Canola is a poor competitor with weeds. Flea beetles attack the crop, especially during germination and the early stages of growth, and cause severe yield losses. Growers frequently ask for information on herbicide/insecticide mixtures in order to effectively control all of these pests. Preliminary tests at the Brandon Research Station have indicated that

two flea beetle insecticides, Ripcord (cypermethrin) and Furadan (carbofuran), in tank mix did not affect wild oat control by several grass herbicides at their recommended rates. The mixtures increased canola yield substantially as compared to that when grass herbicides were applied alone (Tables 6 and 7). However, data in the Tables did not indicate the extent to which the insecticides contributed to increases in canola yield. More tests are needed to determine the effect of insecticides on canola.

Table 6. Effect of Ripcord on wild oat control by grass herbicides and on canola yield, 1982

Treatment (kg/ha)	Wild oat control Seeds (g/m^2)	Tower yield (g/m^2)
Untreated check	35.6	72.9
Hoe-Grass, 0.7	8.9	126.7 (100)
Hoe-Grass, 0.7 + Ripcord, 0.02	6.6	150.6 (119)
Poast, 0.25	7.9	156.6 (100)
Poast, 0.25 + Ripcord, 0.02	4.1	178.4 (114)
Dowco 453, 0.01*	32.7	73.4 (100)
Dowco 453, 0.01 + Ripcord, 0.02	25.3	86.5 (118)
WL 43423, 0.42	11.5	135.9 (100)
WL 43423, 0.42 + Ripcord, 0.02	4.9	151.7 (112)

* This rate was 10 times lower than the recommended rate by miscalculation.

Table 7. Effect of Furadan on wild oat control by grass herbicides and on canola yield, 1983

Treatment (kg/ha)	Wild oat control Seeds (g/m^2)	Candle yield* (g/m^2)
Untreated check	74.8	62.4
Hoe-Grass, 0.7	20.7	92.8 (100)
Hoe-Grass, 0.7 + Furadan, 0.1	16.6	103.0 (111)
Poast, 0.25	3.8	88.5 (100)
Poast, 0.25 + Furadan, 0.1	1.7	94.3 (107)
Dowco 453, 0.1	1.3	81.9 (100)
Dowco 453, 0.1 + Furadan, 0.1	1.5	94.3 (115)
CGA 82725, 0.25	3.4	69.6 (100)
CGA 82725, 0.25 + Furadan, 0.1	0.9	100.8 (144)

* Average of 3 replicates.

IV. Interaction and Incompatibility

Two or more pesticides added together may or may not produce interactions of a chemical or physical nature. The interaction may be antagonistic or synergistc in terms of effectiveness of pest control. They may also be defined as incompatibility of the chemicals being mixed in the spray tank.

Antagonism in a mixture with two or more pesticides often occurs. If the antagonistic effect of one herbicide on another herbicide is rate-dependent, this may be corrected by adding the second herbicide at a higher rate. For example, MCPA amine reduced wild oat control by Poast (0.1 kg/ha). This antagonism heightened as the rate of MCPA amine increased from 0.2 to 0.6 kg/ha (Table 8). However, the antagonistic effect of MPCA amine on Poast decreased as the rates of Poast increased from 0.1 to 0.3 kg/ha.

Incompatibility of pesticides in mixture may result in poor pest control, downtime for spray applicators, and financial loss.

Table 8. Rate-dependent antagonism between Poast and MCPA amine for wild oat control

Treatment (kg/ha)	Colby's formula response differences*		
	MCPA 0.2 kg/ha	MCPA 0.4 kg/ha	MCPA 0.6 kg/ha
Poast, 0.1	-9.5	-12.4	-16.5
Poast, 0.2	-8.8	-7.5	-6.7
Poast, 0.3	-3.7	-5.7	-0.5

* Negative values indicate antagonism between two herbicides according to the Colby's formula.

In summary, pesticide mixtures have several advantages and disadvantages as discussed. They require a great deal of laboratory testing as well as study in the greenhouse and out in the field. Without recommendations, it is unwise for growers to mix pesticides. Correct use of herbicide mixtures is the key to obtaining effective pest control and maximum crop production.

A REVIEW OF THE DEVELOPMENT OF SELECTIVE GRAMINACEOUS HERBICIDES

G. Marshall
Department of Plant Science
University of Manitoba

Introduction

This review is concerned with the introduction and development of post-emergence herbicides which are used to selectively control a range of graminaceous plants. Since the gramineae (grass family) is primarily associated with cultivated crop plants, it is important to clarify the way in which herbicide selectivity asserts its value in terms of agronomic weed control. The benefit of achieving grass weed control is certainly not restricted to graminaceous crops but also to within a range of dicotyledon (broad leaved) crops where grass weeds have previously been difficult if not impossible to control by post-emergence herbicides. Under prairie conditions the term grass weed implies wild oats (Avena fatua L.), green foxtail [Setaria viridis (L.) Beauv.], volunteer cereals, and of lesser importance Barnyard grass [Echinochloa crusgalli (L.) Beauv.], Persian darnel (Lolium persicum Boiss. & Moh.) and common couch grass [Elymus repens (L.) Gould.]. By nature of the range and competitive effects which these weeds can assert in a range of crops, it is not surprising that chemical companies have pursued the development of these herbicides with some vigor.

First Generation Herbicides.

The introduction of selective graminaceous herbicides commenced in 1975 with dichlofop-methyl (Hoe 23408). Dichlofop-methyl is used for post-emergent control of annual grass weeds, principally wild oats in wheat and barley, although its use can be extended in soyabeans, flax, lentils, oilseed rape, sunflowers, sugar beet, and a selection of broad-leaved horticultural crops. While this herbicide may represent the embryonic stage in the development of graminaceous herbicides, it has proven to be a very valuable asset in the campaign to control wild oats. The mechanism of action which confers the herbicidal properties of toxicity and selectivity have been examined comprehensively, however, remain beyond the scope of this review. Following the application of dichlofop-methyl, susceptible species show wilting followed by chlorosis in the shoots, growth of roots and shoots ceases and plant death ensues. In practical terms, the limitations of the performance of this herbicide include (1) optimum weeds susceptibility restricted to the 1-4 leaf stage, weed maturity confers resistance, (2) differential tolerance to crop varieties, (3) loss of activity under conditions of soil moisture stress, (4) unsuitable for the removal of volunteer wheat and barley in broad leaved crops, (5) very limited translocation therefore unsuitable for perennial grass weed control.

Second Generation Herbicides.

The next major development was the introduction of the second generation of post-emergence grass herbicides starting with alloxydim-sodium. Discovered by the Nippon Soda Co. Ltd. (1980), alloxydim-sodium was characterized by its remarkable properties of selectivity enabling its widespread use in broad leaved agricultural

crops but also in horticultural fruit, vegetables and container-grown nursery plants. Alloxydim-sodium is absorbed by the foliage and in grass weeds translocated to the sites of meristematic activity, i.e., growing points and buds. The herbicidal activity of this second generation grass herbicide is a product of adequate spray retention, penetration, absorption and translocation to the sites of action, growing points and meristems.

In practice, this herbicide is most effective when applied to actively growing weeds under conditions of adequate soil moisture. Annual grass weeds including volunteer cereals could be controlled. Rhizomatous grass weeds such as common couch [Elymus repens (L.) Gould] could be suppressed by the application of alloxydim-sodium while systematic treatment of foliage regrowth could over time give more permanent control of rhizome regeneration. The limitation which herbicidal activity imposed upon the degree of rhizomatous grass weed regeneration has now been largely removed by the introduction of compounds such as fluazifop-butyl [discovered by (Ishihara Sanyyo Kaisha, Japan, developed by I.C.I.) and sethoxydim (discovered by the Nippon Soda Co. Ltd., developed by BASF)].

Both flauzifop-butyl and sethoxydim are post-emergence translocated herbicides which under favourable conditions, previously described, provide sufficient herbicidal activity for annual grasses to be controlled at a range of growth stages (2-6 leaves). This increased flexibility of application timing gives the opportunity to control the grass weed population more effectively. The activity of both compounds is two to four-fold greater than alloxydim-sodium. Correspondingly, this herbicidal activity can be of value in the control of perennial grass weeds. Since both fluazifop-butyl and sethoxydim are active at relatively low rates the selective removal of grass weeds in broad-leaved crops becomes an economically attractive means of controlling unwanted volunteer cereals and other grass weeds.

While fluazifop-butyl and sethoxydim control a range of grass weeds their activity towards individual species within the grass family does vary significantly. Sethoxydim shows a high degree of activity against green foxtail while fluazifop-butyl is less able to control this weed at equivalent rates. On the other hand fluazifop-butyl actively controls volunteer barley at low rates while sethoxydim does not. So far the mechanism of inter-weed species tolerance to these selective graminaceous herbicides has not been reported.

Progress continues to be made with regard to achieving maximum herbicidal activity using minimum dose while reliability of weed control is maintained. Research has shown that the inclusion of various surfactants or oils in the spray solution can enhance the activity of most selective grass herbicides. In practice fluazifop-butyl and sethoxydim are recommended for application with a non-ionic surfactant and oil concentrate respectively.

While the benefits of this group of grass herbicides have been examined it must be remembered that these herbicides provide a selective advantage to dicotyledon crops but also to dicotyledon weeds. The selective removal of agressive grass weeds such as volunteer cereals may exacerbate the competitive effects of broad-leaved weeds if they are not controlled. Logically one would wish to control grass and broad-leaved weeds simultaneously in one

sprayer operation and therefore tank-mixing of herbicides is required. Indescriminate mixing of herbicides can produce serious detrimental effects on the activity of one or both herbicides in the mixture but also decreased crop tolerance producing phytotoxic symptoms. Such antagonisms are complex and not particularly well understood. This is not surprising since the mode of action of the grass herbicide may only have received preliminary investigations. Herbicide compatibility studies will require considerable input to assess the safety and efficacy of the multitude of herbicide combinations which are desired under a range of broad-leaved crops.

The Future.

Future developments in selective graminaceous herbicides will reflect current research efforts focused on the basic requirements of this group of herbicides (i) selectivity, (ii) toxicity or activity in the target weed species and (iii) compatibility with other groups of herbicides. Now that compounds such as fluazifop-butyl and sethoxydim have established a valuable niche in arable crop production all newcomers must have equivalent or superior performance. The scope for the introduction of new compounds is now becoming more limited. Already we have seen several promising grass herbicides dropped from further development. However, the evolution of selective graminaceous herbicides may follow a route of greater diversification than those first and second generation compounds.

Registration of existing or new selective grass herbicides may be extended to include a wider range of broad leaved agricultural and horticultural crops. It may also be possible to manipulate the basic active ingredient to selectively control grass weeds in broad leaved and cereal crops. Tolerance of a crop to a herbicide is normally genetically determined, i.e., a characteristic which is inheritable, passed from generation to generation. An alternative approach to achieve selectivity involves the use of a chemical protectant (antidote or safener) which is applied to the crop seed or incorporated in the spray solution. The practical value of this attractive development is currently being evaluated in herbicides such as HOE 33171 for its potential as a graminaceous herbicide in cereals (HOE 33171 + Safener, A21 = HOE 7105) or in broad-leaved crops (HOE 33171). It is interesting to speculate that selective grass herbicides founded in dichlofop-methyl may evolve to control a range of annual and perennial grass weeds in cereals and broad leaved crops.

The use of selective graminaceous herbicides may be developed further in special conditions of crop production. The problem of soil erosion is already receiving considerable attention with regard to matching cultivation practice, the selection of crop species and time of sowing or planting towards soil conservation. Spring wheat sown early as a nurse crop to prevent soil erosion can subsequently be selectively removed after sugar beet has been drilled and established using a selective graminaceous herbicide.

GREEN FOXTAIL (*Setaria viridis*) COMPETITION AND CONTROL IN RUSSET BURBANK POTATOES

D.A. Wall
Agriculture Canada
Morden, Manitoba, ROG 1JO

Green foxtail [*Setaria viridis* (L.) Beauv.] has, in recent years, replaced wild oats as the most troublesome grassy weed in Manitoba (5). Alex et al. (1972), found that green foxtail was present in 84% of all fields surveyed in Manitoba, and that 43% of the infestations included 1,000 or more plants per meter square. Densities of green foxtail at which crop yields are reduced vary from year to year, appearing to be dependent upon soil temperature and moisture conditions at seeding time and during early growth stages (2). Where green foxtail has been reported as the predominant weed species in potato weed control studies, significant yield reductions have been recorded at densities of less than 150 plants/m^2 (3).

In 1983 and 1984 green foxtail was sown by hand at target densities of 0 to 800 plants/m^2 to assess the effect of foxtail interference on the yield and quality of Russet Burbank potatoes. Green foxtail at densities of 18 and 42 plants/m^2 resulted in significant reductions in the total and marketable yields and in the number of marketable tubers in 1983 and 1984, respectively. Marketable yields followed closely the density of green foxtail below 150 plants/m^2, at densities above 150 plants/m^2 increasing density had a negligible effect on marketable yield. Green foxtail interference had no significant effect on either specific gravity or color of chipped potato tubers.

In 1982 and 1983 diclofop-methyl, sethoxydim, fluazifop-butyl, haloxyfop-methyl and CGA 82725 were evaluated for the control of green foxtail in Russet Burbank potatoes. Potatoes exhibited excellent tolerance to all treatments. Fluazifop-butyl failed to provide acceptable control of green foxtail, resulting in yields significantly less than those recorded in the weeded check but not significantly different from those plots having received applications of the other grass specific herbicides (Table 1).

In 1984, grass specific herbicides were evaluated either as a post-emergent treatment following metribuzin applied pre-plant incorporated or as a post-emergent tank mix with metribuzin. Russet Burbank potatoes exhibited excellent tolerance to all combinations. Application of the metribuzin pre-plant incorporated followed by the grass specific herbicide post-emergence significantly improved the control of green foxtail when compared to the post-emergence tank mixtures (Table 2). This is not thought to be suggestive of antagonism by metribuzin in the tank mix, but reflects rather the herbicidal activity of metribuzin on the green foxtail when applied pre-plant incorporated. There was no difference in the control of green foxtail between grass specific herbicides when applied as a split-application with metribuzin. However, when the grass specific

herbicides were applied in a tank mix with metribuzin it was found that fluazifop-butyl at 0.175 kg a.i./ha failed to provide acceptable control of green foxtail. Sethoxydim, haloxyfop-methyl, DPX Y6202 and HOE 33171 all provided an equal degree of control of green foxtail when tank mixed with metribuzin. There were no significant yield differences between treatments containing grass specific herbicides.

LITERATURE CITED

1. Alex, J.F., J.D. Banting and J.D. Gebhardt. 1972. Distribution of Setaria viridis in Western Canada. Can. J. Plant Sci. 52(2) 129-138.

2. Blackshaw, R.E., E.H. Stobbe and A.R.W. Sturko. 1981. Effect of seeding dates and densities of green foxtail (Setaria viridis) on the growth and productivity of spring wheat (Triticum aestivum). Weed Sci. 29(2) 212-217.

3. Chitsaz, M. and D.C. Nelson. 1983. Comparison of various weed control programs for potatoes. American Potato J. 60: 271-280.

4. Nelson, D.C. and M.C. Thoreson. 1981. Competition between potatoes (Solanum tuberosum) and weeds. Weed Sci. 29: 672-677.

5. Thomas, G. 1982. 1981 Weed Survey of cultivated land in Manitoba. Manitoba Dept. of Agriculture, Publ. 82-1.

Table 1. Control of green foxtail in Russet Burbank potatoes with grass specific herbicides. Two year average (1982 to 1983).

Herbicide treatment[a]	Rate (kg a.i./ha)	Green foxtail density[b] (#/m^2)	Marketable tuber yield (t/ha)
Diclofop-methyl	1.0	13 c	9.3 ab
Sethoxydim	0.35	10 c	11.3 ab
Fluazifop-butyl	0.35	65 b	8.3 b
Haloxyfop-methyl	0.125	8 c	9.7 ab
CGA 82725	0.3	7 c	9.9 ab
HOE 00736	0.25	22 c	10.4 ab
Weeded check	-	0 c	11.9 a
Weedy check	-	205 a	3.9 c

[a] Sethoxydim and CGA 82725 plus Assist Oil Concentrate at 0.5% (v/v), Haloxyfop-methyl plus Canplus 411F at 0.1% (v/v) and fluazifop-butyl plus Agral 90 at 0.1% (v/v).

[b] Means within columns followed by a common letter are not significantly different according to DNMRT (P = 0.05).

Table 2. Metribuzin combinations with grass specific herbicides for the control of green foxtail in Russet Burbank potatoes.

Herbicide treatment[a]	Rate (kg a.i./ha)	Applied	Green foxtail density[b] (#/m^2)	Marketable tuber yield (t/ha)
Metribuzin/Sethoxydim	0.28/0.25	ppi/post	0 d	16.9 ab
Metribuzin/Fluazifop-butyl[c]	0.28/0.175	ppi/post	2 cd	16.9 ab
Metribuzin/Haloxyfop-methyl	0.28/0.1	ppi/post	1 d	19.0 a
Metribuzin/DPX Y6202	0.28/0.125	ppi/post	0 d	19.7 a
Metribuzin/HOE 33171	0.28/0.3	ppi/post	0 d	13.7 bc
Metribuzin+Sethoxydim	0.28+0.25	post	16 b	15.5 abc
Metribuzin+Fluazifop-butyl	0.28+0.175	post	63 a	17.6 ab
Metribuzin+Haloxyfop-methyl	0.28+0.1	post	19 b	16.7 ab
Metribuzin+DPX Y6202	0.28+0.125	post	9 bc	18.8 a
Metribuzin+HOE 33171	0.28+0.3	post	13 bc	18.5 ab
Metribuzin	0.28	post	81 a	11.3 c
Weeded check	-	-	0 d	16.7 ab
Weedy check	-	-	85 a	6.5 d

[a] Sethoxydim and DPX Y6202 plus Assist Oil Concentrate at 0.5% (v/v), Haloxyfop-methyl plus Canplus 411F at 0.1% (v/v).

[b] Means within columns followed by a common letter are not significantly different according to DNMRT (P = 0.05).

[c] Fluazifop-butyl = TF 1195.

SEMI-DWARF WHEATS IN THE MARKET PLACE

As wheat processors, we have a considerable interest in the production of semi-dwarf wheat varieties.

We are concerned with the increasing production of unlicensed semi-dwarf varieties, because of their visual similarity to CWRS wheat. These semi-dwarf varieties can have substantial effect on mill results and flour quality.

HY320 is a more attractive option than unlicensed varieties because of its visually distinctive kernel. This allows us to control its inclusion in our wheat blends.

As flour millers, we are subject to intense regulation that is unique in Canadian Industry. Our main raw material, wheat, is closely regulated by Government Agencies and Boards. Familiar to everyone is the Canadian Wheat Board, which is the only source of supply for western domestic milling wheat and has a major influence over our industry. They establish the price and regulate almost every facet of the transportation of western wheat. The Ontario Wheat Producers Marketing Board performs similar functions for Ontario grown domestic milling wheat.

With the C.W.B. having control over many variables, the one key element we can control is wheat quality. In Canada, we are fortunate in having top quality home grown milling wheat available, with excellent grade segregation. This ensures we can obtain reasonably uniform quality from parcel to parcel.

Our control over the purchasing of the milling wheat is critical, especially when you consider this raw material accounts for 70 to 80% of the selling price of our end products.

As millers we blend wheat of different qualities and strength factors together for milling into our different kinds of flour.

Our primary products are:
1) bakers flour
2) consumer flour
3) starch plant flour
4) cake and pastry flour
5) specialty flour

The quality of flour to be expected is assessed from

detailed physical and chemical analysis of the wheat. The test criteria are based on milling process parameters, baking parameters, and on the required characteristics of the end use product, such as a baked loaf of bread.

The ultimate use of the flour is our most important consideration. We must ensure that flour for bread-making makes good bread, and flour for cakes makes good cakes. Flour for starch and gluten must meet the starch and protein requirements of that industry.

Choosing the blend of wheats for a grist to strike the correct balance between costs of raw material, the quality of flour required, and profitability, demands considerable skill, experience and judgement. One of our greatest aids to success is the availability of grades and protein levels of wheat which can be relied upon to yield a consistent amount of flour of uniform baking quality.

Over the past few years large quantities of unlicensed semi-dwarf wheat varieties have been grown.

As millers, we are always encouraging the development, and assisting in the testing of new milling wheat varieties. However, we insist that all varieties undergo the thorough testing programs now in place, before embarking on a full scale program, as is now being done with HY320.

We do not rule out the inclusion of high yielding varieties in the Canadian grain system. There is, however, a danger in introducing varieties such as a Solar.

These varieties pose a threat to our ability to continue producing the high grade flours required by the baking industry in Canada.

Because these varieties cannot be distinguished visually from CWRS, we are concerned that we could lose control of our wheat selection and wheat grists. It is important that these wheat varieties do not become incorporated into the prime milling grades.

As a consumer how would you react if your next loaf of bread were only half as high? Having milled some of the Solar variety, we find this wheat to have sub-standard breadmaking quality. What we have seen is low-water absorption, poor dough making qualities and reduced loaf volume. These are not acceptable within the context of the Canadian licensing system in that they are not equal to the standard variety, Marquis.

In view of the fact that any new variety must meet this criteria when presented as a new cultivar, so must any imported variety when submitted to the Expert Committee on Grain Quality. It is obvious that the entire system of quality control is being threatened by the inclusion of these varieties in wheat grades other than Canada Feed.

We believe it is the direct responsibility of the Canadian Grain Commission to ensure that CWRS grades contain only those varieties which have been approved for license by the Expert Committees appointed by Agriculture Canada.

As mentioned earlier based on our milling assessment and subsequent evaluation of Solar wheat we found this wheat unsuitable for breadmaking flour. However, this wheat was quite adequate as a blend for wheat starch and gluten, given a reasonable protein level. A price sufficiently below CWRS will provide us the required economic justification. We must remember that not all flour is destined for breadmaking and the criteria is different for the starch industry,which is more adaptable to different wheat varieties.

In contrast to the Solar Wheat, HY320 was introduced in a controlled, orderly fashion. The data was collected and analyzed at all steps of the introduction. This is the correct procedure for new variety testing.

The HY320 concept is the concept of "Triple M" wheat. That is medium protein, medium hardness, and medium gluten strength. It is an attempt to improve yield without sacrificing milling quality. HY320 must prove to have an average quality good enough to warrant milling. In other words, it must produce a consistent and uniform quality flour.

We have found that HY320 produced an acceptable quality cake flour when milled on a soft wheat mill. We have had poor performance when used on a Hard Spring mill.

The flour is suitable for certain types of noodles and flat breads. It has been unsuitable for breadmaking. It has also given poor results for starch because of the low protein and difficult millability.

The milling potential of HY320 will ultimately depend on the market place, which takes into account the end use and the price it will command relative to other wheats.

Since HY320 is visually distinguishable from CWRS it presents no problem in selection or blending, and we simply treat it as another class of wheat.

All semi-dwarfs introduced to date must be considered as such and cannot be considered for milling grades.

Unfortunately as millers we are really caught in the middle. On one side we have our customers who demand high quality flour. On the other side are our suppliers, the producer, who is trying to achieve better profit by increasing yields.

We are concerned when we see producers eroding their existing markets by the production of low quality unlicensed wheat varieties. The producer is risking loss of markets that have taken years to build. This is not the correct way to develop customer relations.

We must strive to have new varieties developed that are suitable to the producer, the miller and the ultimate consumer. We must be able to analyze the yield of these new varieties, the milling efficiency and then test market the flour.

Co-operation and respect are attitudes which are evident in the grain industry, these have resulted from experience and trust. With continued co-operation between the parties involved, we can solve all of these problems and achieve a superior product for all.

AGRONOMIC PERFORMANCE OF AMERICAN SEMIDWARF VARIETIES

W. S. Ball, Extension Agronomist

North Dakota, along with other northern states, has grown high protein hard red spring wheat for about 100 years. Most of the earlier varieties grown were high protein awnless types similar to Marquis. Since the early 1920's all of them were carefully screened for quality and those considered to be of low quality were not recommended nor released by public agencies. In the late 1960's high yielding semidwarf HRSW varieties were developed through the CIMMYT international breeding program and were registered and sold by private companies. Most of these were lower quality varieties with high yields and strong straw. Because of the high yields, many farmers purchased seed and raised these varieties. Also in 1970, Minnesota released a semidwarf variety named Era that had a substantial yield advantage over Waldron in most regions of North Dakota and Minnesota.

To counter the effect of these varieties, the NDSU wheat breeding program began to release strong strawed semidwarf wheats with somewhat better quality than the earlier semidwarfs. The first of these was Olaf released in 1973 followed by Len in 1979. The quality of Olaf was not up to historic standards but was the best combination of yield and quality available at that time. Olaf was planted on 35 percent of the spring wheat land in 1978 (Table 1). Len, released in 1979, had slightly better yield than Olaf and was superior in most quality characteristics. Len reached a maximum of 28 percent of the acreage in 1982 but has dropped back to 22 percent in 1984 (Table 2).

Table 1. North Dakota Wheat Production, Percent of Variety Planted.

		Year	
Variety	Type	1972	1978
Waldron	med-tall	53	28
World Seed 1809	semidwarf	11	--
Chris	med-tall	9	--
Bounty 208	semidwarf	3	--
Era	semidwarf	--	4
Bonanza	semidwarf	3	--
Olaf	semidwarf	--	35

Table 2. North Dakota Wheat Production, Percent of Variety Planted.

		Year			
Variety	Type	1980	82	83	84
Olaf	semidwarf	27	27		8
Len	semidwarf	2	28		21
Marshall	semidwarf	--	--		22
Solar	semidwarf	7	7		2
Butte	med-tall	22	16		8
Waldron	med-tall	19	10		7
Oslo	semidwarf	--	--		5

Four-year statewide yields of Len were slightly less than Era and 229 kg/ha less than Marshall (Table 3). Farmers usually will not shift to lower protein varieties if yield advantage is less than 200 kg/ha. However, Table 4 shows that Marshall has a yield advantage of over 400 kg/ha at Langdon, but has a slight disadvantage at Fargo. In 1984 Marshall was planted on 52.2 percent of the acres in the Langdon district and only 19.3 percent in the Fargo district. This shows that farmers are highly influenced by yield data in making their variety selections.

Table 3. Spring Wheat Yields, North Dakota, 1978-82.

Variety	Five locations yield (kg/ha)
Len	3185
Era	3286 + 101
Marshall	3414 + 229

Table 4. Spring Wheat Yields and Percent Planted.

Station	Len	Percent 1984	Marshall	Percent 1984
Williston	2696	14.4	3024	6.8
Minot	3044	17.1	3313	8.4
Carrington	3158	22.4	3461	33.4
Langdon	3696	7.4	4153	52.2
Fargo	3232	31.5	3125	19.3

North Dakota - 1978-82 - kg/ha

Other varieties recently released such as Oslo wheat or 2369 may yield even more than Marshall and may be planted by many farmers (Table 5). The newest NDSU release Stoa is not a semidwarf but will yield more than Len and about the same as Oslo. It has good quality but not as good as Len.

Table 5. Hard Red Spring Wheat Yields, Langdon, North Dakota.

Variety	3-year average (kg/ha)	% of Waldron
Oslo	3810	119
Len	3662	114
Wheaton	3601	112
Solar	3575	112
Columbus	3219	100
Waldron	3205	100

Over the years, spring wheat varieties raised in North Dakota have declined in protein and overall quality. However, as Table 6 shows, our wheat breeders and cereal chemists have been able to maintain quality levels in varieties such as Len and Stoa despite a decline in protein.

Table 6. Hard Red Spring Wheat, 1982-83.

Variety	Percent Vitreous Kernels	Percent Protein	Loaf Volume
Columbus	90	16.3	880
Waldron	89	15.7	881
Len	90	15.4	919
Alex	89	15.2	888
Stoa	87	15.1	897
Butte	87	15.0	845
Erik	81	14.7	800
2369	73	14.3	808
Marshall	87	14.3	811
Oslo	62	14.0	825
Solar	86	13.7	827

Source: Dept. of Cereal Chemistry, NDSU.

In summary, under the U.S. system, variety yields must be continually increased without undue sacrifice of quality if satisfactory quality standards are to be maintained. If Waldron was still the best high quality variety available at least 80 percent of the North Dakota farmers would be planting lower quality semidwarf varieties.

INTENSIVE MANAGEMENT OF WINTER WHEAT ON THE PRAIRIES

D.R.S. Rourke
and E.H. Stobbe
Department of Plant Science
University of Manitoba
Winnipeg, MB, R3T 2N2

Intensive cereal management (ICM) is a management philosophy where the objectives are to reduce unit production cost by optimizing production inputs. Crop yields will be maximized with the net effect of increasing profits.

Sounds great, but is ICM a reasonable, reliable approach in the Prairies where many successful farming operations have relied on being extensive rather than intensive. While Prairie farmers are among the most efficient in terms of grain production/unit of labour, they are relatively inefficient in terms of grain production/unit land area. Perhaps it is time to reevaluate Western Canadian grain production potentials.

The objectives of this paper are: to demonstrate the potential for ICM under the environmental constraints of our prairie climate; to demonstrate the suitability of winter wheat for ICM in the prairies and to develop an ICM package for maximizing the yields of winter wheat.

ENVIRONMENTAL CONSTRAINTS

Are the prairies too dry for ICM?

Moisture availability is probably one of the most important environmental constraints on the Prairies. Annual precipitation as shown in Figure 1 (Chapman and Brown) is quite variable over the Prairie region, from a high of 550 mm in south eastern Manitoba to a low of 300 mm west of Swift Current. Many studies have shown that crop yields are directly related to the moisture availability (Brown and Black, 1983). To more accurately describe the moisture requirements for wheat, Dunlop and Shaykewich (1982) have developed a number of maps describing the soil moisture status.

Figure 2 illustrates that the average soil water status (mm) at the soft dough stage of spring wheat in most of Manitoba is essentially zero. Spring wheat on an average year would not benefit from irrigation, except for a small area around Morden and the southwest corner, which would require 25-50 mm of irrigation water to eliminate stress. Figure 3 illustrates the poorest soil water status (mm) which can occur with a 25% risk. In one out of four years, 50 mm of irrigation water would be required to eliminate water stress in spring wheat in the majority of the province. It is estimated that winter wheat due to its early spring growth, early maturity, and extra moisture available from snow trap may have as much as 50 mm more moisture available. The 50 mm moisture advantage winter wheat has compared to spring wheat would allow winter wheat to grow in three out of four years without moisture stress.

Are the prairies too dry for ICM?

Not necessarily.

SUITABILITY OF WINTER WHEAT FOR ICM IN THE PRAIRIES

Besides improved moisture utilization, winter wheat also has other attributes which make it the ideal crop for production using ICM. For example, winter wheat grows for approximately 40 days in

the fall and 105 days in the spring for a total growing season of 145 days compared to 100 days for spring wheat. The longer growing season can result in more extensive root development, vegetative development and reproduction capacity. The early growth in the spring allows winter wheat to better utilize the long days of May and June to maximize the assimilation rate. While winter wheat can still suffer from heat stress, due to its earlier maturity, the period of heat stress is shorter and often coincides with less critical stages of development than normally found with spring wheat.

Until recently the production of winter wheat has been limited to the more moderate climates of southern Alberta and the southwest corner of Saskatchewan. However, advances in the agronomy of winter wheat, primarily by using the standing stubble of the previous crop to trap snow, have allowed the creation of a micro-environment in which winter wheat survival is virtually guaranteed.

Excellent winter survival combined with unique capability to minimize the limitations of our climate give winter wheat the potential to be the most highly productive crop on the prairies. Winter wheat is the crop which will give the maximum response to the high level inputs in an ICM program.

DEVELOPING AN INTENSIVE CEREAL MANAGEMENT PACKAGE

ICM winter wheat trials were initiated in 1981 by the University of Manitoba, Department of Plant Science at Minto and Portage la Prairie Field Stations. These trials have studied the effect of cultivars, nitrogen fertilizers, plant growth regulators (PGR), fungicides, seeding dates, seeding depth and their interaction on the yield of winter wheat. The results of these trials along with information from other sources have been assembles into an ICM package for winter wheat with a target yield of 5-6 tonnes/ha.

The ICM package consists of 17 factors as follows:

1. Crop rotation — Winter wheat should follow rapeseed, to minimize problems with root rots and volunteer grains.
2. Cultivar — Norstar.

Results of our research trials show that maximum yields are only obtained from the most winter hardy cultivars. Figure 4 illustrates the performance of a number of cultivars of winter wheat grown under two micro-climates at Minto, Manitoba in 1982. Even using zero tillage techniques, the highest yields were obtained from the most cold hardy cultivars, such as Norstar. Less hardy cultivars often had poor yields under zero till and were completely winter killed under severe micro-climate, conventional tillage. Winter hardy cultivars such as Sundance have the potential to produce yields up to 7.5 t/ha. in Manitoba.

3. Seed quality — Use pedigree seed which has been sized to ensure plump vigorous seed.
4. Seed treatment — Vitavex
5. Seeding date — First week in September
6. Seeding depth — 2.5 cm

The importance of determining optimum seeding date and depth are shown in Figure 5. The highest yields were obtained when winter wheat was planted early in September and planting depth was 2.5 cm.

The difference in yield between seeding at the optimum date and rate compared to seeding at 10 cm in late September was 2500 kg/ha (37 bu/acre). While this difference represents the two extremes, differences between seeding at the optimum time and depth and seeding just slightly later (mid-September) and slightly deeper (5.0 cm) can also cause significant losses in potential yield. In this case, the difference would be 600 kg/ha (8.9 bu/acre).

7. Seeding rate	90 kg/ha.
8. Seedbed	Undisturbed stubble with chaff and straw distributed evenly.
9. Seeding equipment	Adapted zero tillage drills with positive depth control.
10. Row spacing	As narrow as zero tillage seeding equipment will allow, generally 17 cm.
11. Weed control	Control perennial weeds such as quackgrass before winter wheat is seeded. Winter annuals should be controlled just prior to freeze-up or in early spring. Winter wheat is competitive with spring germinating weeds, and chemical weed control is not usually required.
12. Fertilizer	Forty kg/ha P_2O_5 with the seed. Soil tests do not currently call for K, S or micronutrients. However, tissue analysis suggest that S and zinc are marginal for maximum yields. A small amount of nitrogen should be applied with the seed to ensure sufficient fall growth. Eighty kg/ha of nitrogen broadcast in early spring using ammonium nitrate. Forty kg/ha of nitrogen to be broadcast at growth stage 6 (Feekes) using ammonium nitrate. An additional forty kg N/ha may be applied at growth stage 9 provided the crop is growing vigorously and moisture is adequate.
13. Plant growth regulator	Apply 1.38 kg ai/ha of Cycocel Extra to the winter wheat at growth stage 6 (Feekes).

The results of an ICM fertility x plant growth regulator trial conducted at Minto during 1984 are given in Table 1. Winter wheat yields were increased by applications of nitrogen up to 120 kg/ha. Higher rates of nitrogen were tested but not found to be effective.

The split application treatments, where 80 kg N/ha was applied in early spring and 40 kg N/ha applied at growth stage 6 (Feekes) in combination with Cycocel, resulted in the highest yields, 4215 kg/ha (62 bu/acre). This yield was 229 kg/ha more than when 120

kg of N/ha was applied in a single treatment. The application of Cycocel to the split nitrogen treatments increased the yield by 148 kg/ha.

The results of a similar trial conducted at Portage la Prairie during 1984 are shown in Table 2. The rate of nitrogen added to this trial was 120 kg/ha. The application of Cycocel increased yields 564 kg/ha (8.4 bu/acre) to result in a grain yield of 6.2 tonnes/ha (94 bu/acre).

14. Fungicides — Apply 2 applications of mancozeb (1.8 kg ai/ha). The first at growth stage 9 and second 7-10 days later. Apply only if tanspot or septoria are present on lower leaves or if stem or leaf rust spores have moved into Canada from the south.

The advantages of using foliar fungicides to control diseases in winter wheat were demonstrated during 1983 (Table 3). Tanspot and Septoria glume blotch were the major diseases at McGregor. Yields were increased 27% when mancozeb was pplied to Norstar as compared to the untreated plots. Stem rust was the major disease at Minto.

Grain yield was 63% higher than the checks when mancozeb was applied to control stem rust. Fungicide trials conducted in 1984 showed that other fungicides such as Tilt may also give effective control of foliar diseases in winter wheat.

15. Insecticides — Apply as required to control damage by grasshoppers, cereal armyworms or aphids.

16. Method of application — The use of ground application of post seeding equipment employing tramlines is a cost effective method to ensure treatments are applied at the optimum time and uniformly. Often ground application equipment can provide improved spray coverage of plants compared to aerial application, resulting in improved performance of PGR's and funcigides.

17. Harvest — Norstar is adapted to either windrow or straight combining techniques.

The package presented here does work to maximize yields. In 1984 on an 80 acre field at Minto, I was able to obtain 4.0 t/ha of Norstar winter wheat. This was an exceptionally good yield considering this field received only 93 mm of rainfall during the growing season and no rain during the last 4 weeks of development. Farmers at Portage la Prairie where rainfall totals and distribution were more favourable were able to produce up to 5.4 tonnes/ha.

LIMITATIONS OF INTENSIVE MANAGEMENT OF WINTER WHEAT

The package, however, does not guarantee maximum net profits. Much more research is required before we can ensure the optimum use of every input and that the recommended ICM package will maximize farmers net profits.

CULTIVAR: New cultivars must be developed which grow more quickly in the spring to better utilze long spring days. New cultivars should be more resistant to lodging and diseases and have a higher grain to straw ratio than Norstar. Currently grown cultivars in Europe have grain/straw ratio of .50-.65, while grain/straw ratio for Norstar is only .35-.40.

FERTILIZER: The fertilizer practices suggest in the package have generally given the highest yield, however, our trial results have not always shown an ecomomic advantage. The optimum nitrogen rate and time for Norstar will depend on the residual fertility of the soil and growing conditions. We presently have no research information on the use of potassium or micro nutrients in winter wheat.

GROWTH REGULATORS: Cycocel applied at growth stage 6 at 1.38 kg ai/ha has generally given good yield responses, however, sometimes the yield increases may not have justified the additional cost. Our trials have also indicated that Cycocel has not always prevented lodging and therefore maximum yields may not have been obtained. Irials at Portage la Prairie during 1984 showed that Cycocel increased yields 564 kg/ha but did not prevent lodging. Trials conducted at Minto show that another PGR, Cerone, was more effective in reducing plant height that Cycocel. Cycocel reduced plant heights by 11%, whereas Cerone reduced plant heights by 25%.

More research is required to determine optimal use of PGR's to prevent lodging and increase yields in the Prairies. Recommendations will undoubtedly differ for areas where lodging is a major limitation such as Portage la Prairie compared to areas where lodging seldom occurs such as Minto.

CONCLUSION:

ICM has the potential to increase the yields of winter wheat in Western Canada. The areas of the Prairies with soil water deficits at or near zero will have the greatest potential to profitably use ICM. In the future top winter wheat yields of 5 to 8 tonnes per hectare will not be uncommon in these areas.

Intensive Cereal Management will only be implemented and profitable if two criteria are met. Firstly, ICM on the Prairies will have to be a flexible system, a system where the level of inputs will be based on the cropping conditions within a single year. Benefits from ICM will not be achieved by controlling diseases which are not present or by adding nitrogen beyond the climatic limitations imposed on the variety. The second criteria is that localized research will be required to develop cultivars and specific recommendations to maximize the net returns under our environmental constraints.

While our research has allowed us to develop an ICM package for winter wheat, it has also shown that we are far from reaching the potential for ICM to maximize winter wheat yields on the prairies. As. U.S. President Ronald Reagan would put it, "You ain't seen nuthin yet".

REFERENCES

L.J. Chapman and D.M. Brown 1966. The Climate of Canada for Agriculture. The Canada food Inventory Report No. 3. Queen's Printer, Ottawa.

Black and Brown 1983. Stubble seeding and fertilization of winter wheat in Western Canada Winter Wheat Conference. June 20, 1983. University of Saskatoon, Saskatoon, Saskatchewan.

S. Dunlop and Shaykewich 1984. Southern Manitoba's Climatate and Agriculture. Manitoba Agriculture.

Table 1. Effect of mancozeb on yield of Norstar winter wheat.

Location	Principle diseases	% Yield increase
McGregor 1983	Tanspot & Septoria	27 %
Minto 1983	Stem rust	63 %

Table 2. Effect of nitrogen and Cycocel on yield of Norstar winter wheat - Minto 1984 -

Cycocel treatment	Grain yield (kg/ha)				
	Nitrogen treatment (kg/ha)				
	0	60	90	120	80/40
YES	1881	3697	3768	3986	4215
NO	1704	3334	3572	4001	4067

Table 3. Effect of Cycocel on yield of Norstar winter wheat
- Portage La Prairie 1984 -

Treatment	Grain yield (kg/ha)
untreated	5650
Cycocel	6214

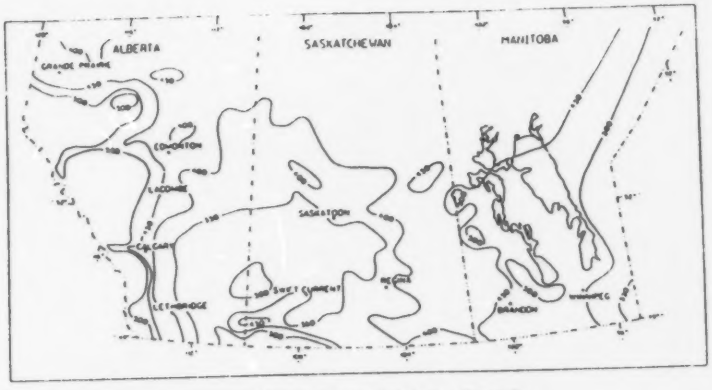


Figure 1. Annual precipitation (mm) - Western Canada

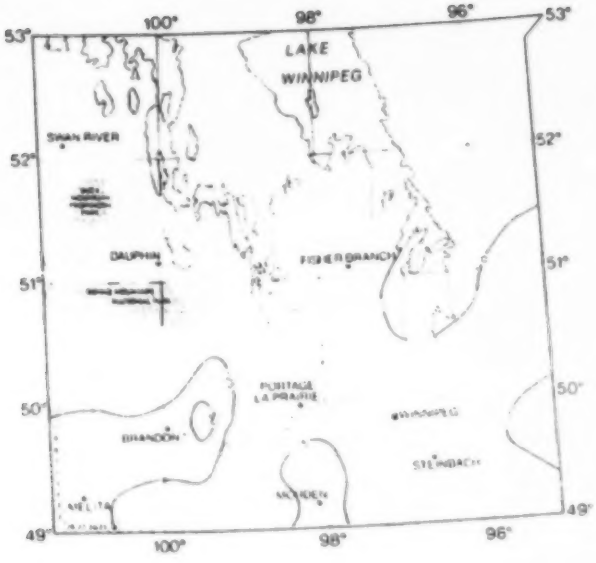


Figure 2. Average soil water status (mm) at the soft dough stage in spring wheat

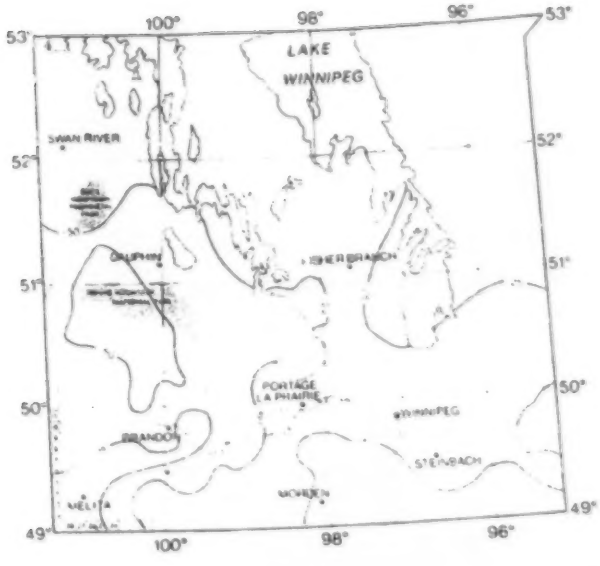


Figure 3. Soil water status (mm) at the soft dough stage in spring wheat which can occur with a 25% risk.

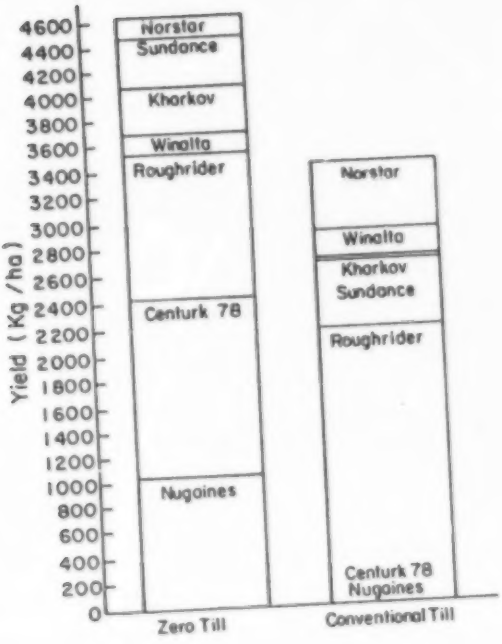


Figure 4. 1981-82 Variety x Tillage Trial.

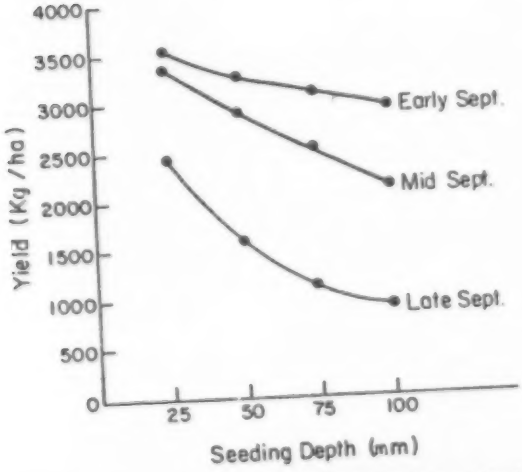
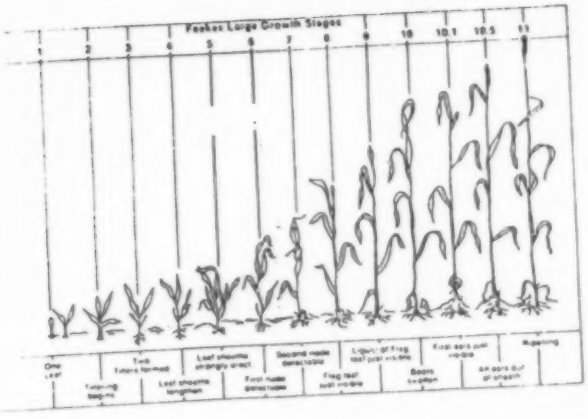


Figure 5. Effect of Date and Depth of Seeding on Grain Yield of Norstar Winter Wheat. Average of 3 Station Years. (Minto and Portage la Prairie.)


Feekes Large Growth Stages
1
2
3
4
5
6
7
8
9
10
10.1
10.5
11

STATE OF THE ART IN ZERO TILLAGE

By

Robert C. McNabb
President
Manitoba - North Dakota Zero-Tillage Farmers' Association

A. INTRODUCTION:

My appreciation to the committee responsible for inviting me on behalf of the Manitoba - North Dakota Zero-Tillage Farmers' Association, to present an update on the status of zero-tillage in Manitoba and North Dakota.

This International Association of approximately 400 members, had its formal structuring in January of 1982 under the guidance of several personnel on both sides of the border.

The purpose of the organization is three-fold:

1. To facilitate the exchange of ideas.
2. To encourage zero-tillage research.
3. To disseminate zero-tillage information.

The inherent purpose of the organization is:

TO PRESERVE OUR AGRICULTURAL RESOURCE FOR FUTURE GENERATIONS BY PROMOTING A SYSTEM OF CROP PRODUCTION WHICH DRASTICALLY REDUCES SOIL EROSION AND BUILDS UP ORGANIC MATTER.

This purpose has significant revelance to the future production capabilities of our soil and will be supported in the conclusion of this presentation.

B. ZERO-TILL - WHAT IS IT AND WHAT ARE THE MAIN BENEFITS?

It is a system of crop production whereby the crop is planted directly into untilled standing stubble with a minimum of soil disturbance, and if necessary, chemical weed control.

The main benefits of this system are:

1. The most effective method of controlling wind and water erosion rather than putting the land into permanent grass.
2. A very effective method of minimizing pollution by fertilizer, chemicals and soils in our rivers and lakes.
3. It will reduce the decline of organic matter particularly on eroded soils.
4. Provide one of the factors necessary for the production of winter wheat.

5. Provide more natural habitat for wildlife.

6. Provide more efficient use of available moisture thus having the potential to reduce summerfallow and consequently salinity.

Field experience has shown that residue management after harvest, fall weed control, crop rotations and the use of a suitable planter are extremely important management factors for successful zero-till crop production. Field research has indicated that with good management, yields are equal to or better than conventional tillage for most crops grown in Western Canada at the present time.

The main area of concern for those practising this system of crop production is to keep it affordable. Chemical costs for control of hard to kill annual and perennial weeds can be greater than the cost of tillage in the short term.

C. ACREAGE UPDATE - MANITOBA AND NORTH DAKOTA:

I. Manitoba Hectares In Zero-Till

1977	-	1,370
1978	-	5,600
1979	-	7,900
1980	-	8,700
1981	-	10,000
1982	-	10,000
1983	-	7,700
1984	-	7,500 (Estimated winter wheat hectarage not included 40,000+ hectares).

II. North Dakota Hectares In Zero-Till

1980	-	5,300
1981	-	16,000
1982	-	35,200
1983	-	85,800
1984	-	260,500 (Includes winter wheat)

Total hectares planted (all methods) in North Dakota - 10,900,000.

III.

A. No-Till	-	260,000
B. Ridge-Till	-	2,800
C. Strip-Till	-	21,500
D. Mulch-Till	-	758,800
E. Reduced-Till	-	809,400
Total Conservation Tillage	-	1,852,500

IV.

Conservation District Drills	-	48
Farmer Owned Drills	-	430
Implement Dealer Leases	-	90

As interpreted from these figures, Manitoba farmers were involved in zero-till ahead of North Dakota, however, hectares peaked in 1981 and 1982 and since declined while North Dakota has almost tripled the acreage every year.

Despite some minor soil and climatic condition difference between Manitoba and North Dakota, the major reason for the hectare variations must be within the policy direction of government agencies.

In 1980, the Soil Conservation Service (SCS), the Cooperative Extension Service (CES), and the Agricultural Stabilization and Conservation Service (ASCS), jointly initiated a 3 year no-till pilot project in North Dakota.

This original project was approved in 5 counties to demonstrate the practical application of no-till farming on a field scale. Objectives of the project were to collect information from operators with no previous experience in no-till farming from areas widely scattered throughout the state.

Guidelines for the program involved:

1. Maximum of 65 hectares.
2. The same field was to be no-tilled each year.
3. A complete set of farm operation and yield records were to be kept.
4. Participation was limited to growers with no previous experience.
5. $49.40 per hectare per year was provided to offset chemical and machinery costs.

This program was extremely successful and has since been replaced by another federal program with the same guidelines and a $37.00 per hectare incentive.

Initially, there may be some thought that the $49.40 per hectare per year payment was the sole motivating factor for farmers to try no-till; however, the fact that 75% of the drills in North Dakota are farmer owned indicates that farmers have been sold on the concept or they would not be makin- capital investments in seeding equipment in light of the present financial returns from crop production.

The original pilot project in North Dakota concluded that cost-share efforts have helped show that no-till is a practical way to maintain crop yields and reduce erosion at the same time. It was also concluded that there was a very real need for more education programs, research, more selective chemicals and better equipment at a price the producer can afford.

In Manitoba - 1984 has brought a significant increase in winter wheat hectares with a good portion of this crop planted in some form of very minimum tillage. This has occurred because of farmers

search for moisture efficient crops but at the same time has the potential to demonstrate, first hand, the no-till concept without a direct financial incentive as in North Dakota.

With this change, there is also some risk and growers of winter wheat should be aware of the disease and rust problems that can affect winter wheat. Some protection is available through fungicides; however at present, only one is registered in Canada and genetic rust resistance is thought to be ten years away.

D. UPDATE ON PRODUCTION METHODS:

1. Seeding Equipment Technology.

   - Commercial companies with zero-till seeding equipment include: Haybuster, Pioneer, Versatile-Noble, Lilliston, Moore, Wil-Rich, United Farm Tool, Amazone, Marliss, Concorde, Victory Equipment.

   - Two of these companies are located in Manitoba.

   - Farmer modified drills consist of: add-on triple disc, offset double disc, offsize double disc, coulter knife and slim hoe openers employing a wide range of packing systems, conventional and air-delivery systems for seed and fertilizer.

   - Some research has been done on optimum row spacing, paired rows and plant populations to obtain maximum yields.

2. Fertility Technology.

   - Trend is towards deep banding or side banding either prior to or at the time of seeding.

   - Many of the commercial drill manufacturing companies have or are working on side banding equipment.

   - Farmers have developed their own systems either at seeding or fall banding with granules, liquids, ammonia or aqua-ammonia.

   - My personal experience has indicated a preference for fall banding with liquid - creates some soil disturbance but has improved timing and equipment operation in the spring.

   - Ideal situation may be to sideband fertilizer at seeding time.

   - Some equipment is now available to regulate and monitor, on the go, fertilizer application for rolling land.

   - Recent development of a cutting coulter for liquid banding.

3. Straw and Chaff Spreading Equipment.

   - Wide spread fins on conventional choppers can spread straw

up to 6 meters.

- "Straw Storm", a modified chopper available for some models of combines and manufactured in Winnipeg by "Keith Industries", can spread straw up to 15 meters.

- Chaff spreaders include paddle type, air blast and fan.

4. Spraying Technology.

- Increase in the use of marking systems:
  - foam system works well
  - tramlining has definite advantages in zero-till and more intensive crop production.

- Ability to extend hours of spraying operation have produced hooded sprayers for wind spraying and lighting systems for night spraying.

- Deflectors on spray booms have shown promise in improved coverage.

- Chemical injectors have shown the capability of applying 2 or more chemicals in one operation.

- Rope wicks, wipers and portable spray units have been developed.

- Recent developments have occurred with electrostatic nozzels in England that indicate improved coverage and reduced drift and lower chemical requirement.

- Computers for setting rates, monitoring rates and rate controllers reduce potential errors in application.

5. Weed Control Technology.

- At present, only two burn-off chemicals available for use at seeding time (Roundup and Sweep).

- Chemicals such as Poast and Fusilade have aided volunteer cereal control in oilseed crops.

- If burn-off control is good at seeding time in crop-spraying is the same as conventional.

- Noticed some movement in area of bulk chemical purchases by farmers in the U.S. This has the potential to improve the operator safety in handling chemicals.

E. RESEARCH REQUIREMENTS:

1. High and direct weed control costs provide a fertile area for improvements in cost-effective weed control i.e. less costly burn-off chemicals. The benefits here are more evident in a minimum-till cropping system due to greater use and reliance

on chemicals, but this technology is directly transferable to conventional cropping.

2. Development of chemical weed control techniques and rates for weeds peculiar to Conservation Tillage i.e. Foxtail Barley, Overwintered Cleavers, Bromegrass and all other weeds present at time of seeding.

3. Develop methods and recommendations whereby a considerably higher percent of the weed spray chemical is placed directly on the plant leaves and stems rather than on the soil or lost into the atmosphere by drift, in order that public opinion may not be opposed to Conservation Till. Some methods may be sprayer hoods, deflectors, electrostatic nozzel designs, etc.

4. Development of recommendations for fertilizer rates, timing and placement for Conservation Till, noting that the fertilizer needs may be peculiar to Conservation Till. For example, with the lack of soil mixing, moisture close to the surface and organic layer on the surface, some nutrients may be less available for plants to effectively use them. An example may be potassium.

5. Development of recommendations for variety and plant family specifically geared to Conservation Till.

6. Development of recommendations for seed placement, soil coverage, depth of seeding, packing over or beside the seed, soil surface topography, realizing there may be different answers for different soil types.

7. Development of information leading to recommendations and control measures on insect shifts or problems that occur specifically with Conservation Till. The winter soil temperature remaining warmer under Conservation Till may have an impact on overwintering fatality rates of harmful or helpful insects.

8. Development of information on plant disease under Conservation Tillage compared to Conventional Tillage. For example, if the host residue stays warmer throughout the winter in Conservation Till, what happens to disease organisms?

9. Development of comparative studies on yields and effects on soil on top of knolls, down sideslopes and bottom areas with regard to comparing the three types of farming: Zero-Till, Minimum Till, and Conventional Till; as well as fertilizer requirements to maintain yields in all areas along with an economic assessment of the various methods.

10. Development of sophisticated designs in residue handling equipment for harvest equipment especially under wide swath conditions i.e. 15 meters plus. This could reduce the residue clearance problems associated with individuals developing seeding equipment. In Zero-Till, better distribution of residue could reduce field operations such as harrowing and eliminate some weed and volunteer grain concentrations.

11. Requirements for research into soil physical properties and chemical activity associated with microbial decomposition and ground water infiltration under both Zero-Till and Conventional Till methods of crop production.

F. CONCLUSIONS AND SUMMARY:

Zero Till Works.

- This no-till system of crop productions, simply stated, stops soil degradation.

- A lot of attention has been focused this year on soil degradation through the Senate Committee report of "Soil at Risk" and the "Agricultural Institute of Canada" publication of "Will The Bounty End?". These reports are up to date and factually document an ever increasing problem. First-hand experience of soil erosion was dramatically evident to each and every one of us in Manitoba during the spring of 1984. Shelterbelts, windbreaks, cover crops and grass barriers may offer some temporary erosion relief for a small area but only through zero-tillage can large scale soil problems be solved effectively and efficiently.

- The Senate Committees report is a comprehensive document containing a number of positive recommendations on what must be done to preserve our soil and water resources. The Committee suggests policy changes that would provide economic incentives to farmers who use soil conserving methods. It offers formulas for property taxes and Wheat Board quotas that could provide incentives to reduce summerfallow cultivation and decrease breaking of native pastures, wetlands, and bush without reducing profit.

- Research and development of new techniques, such as zero-tillage and the development of an information extension system to transfer the technology effectively and accurately are advised.

- The Senate Report warns of ..."Our eroding future"... and urges that federal and provincial governments organize to influence the desired changes throughout Canada's agricultural industry.

IT IS TIME TO PAY HEED TO THE SOIL

- I would conclude by saying that with public agencies, industry and farmers involved in a co-ordinated approach to seek out the answers to the research requirements stated, the precious mantle of topsoil on which rests our strength and confidence can be maintained and improved.

PLASTICULTURE TECHNOLOGY
FOR
VEGETABLE CROP PRODUCTION

L.R. Allen, Manitoba Agriculture

INTRODUCTION

Plasticulture can be defined as the utilization of plastics to influence the soil and/or atmospheric environment in a manner that enhances growth and development of a crop.

The use of polyethylene mulches and mini-tunnels are plasticulture techniques. "Poly" films have long been used for horticultural crop production in other areas of the world, but as recently as 1980 had not been used commercially in Manitoba.

The primary effects of "poly" film on the proximate soil and atmospheric environment are temperature enhancement and moisture conservation. These effects contribute to improved crop utilization of nutrients and moisture leading to more rapid foliar and root growth.

Many vegetable crops respond to polyethylene film, however it may be economical to use it with high value, heat-loving crops such as peppers, eggplant, watermelon, canteloupe and cucumbers.

In 1980 an Agro-Man[1] project was initiated to demonstrate the use and effects of "poly" mulches, mini-tunnels and combinations of mulch and mini-tunnels in the production of several vegetable crops. These crops included green peppers, tomatoes, cucumbers, watermelon, canteloupe, celery and sweet corn. Green peppers, cucumbers, watermelon and canteloupe responded very positively to one or more of the plasticulture techniques.

"POLY" SPECIFICATIONS

Polyethylene mulch is mechanically laid over a well prepared bed prior to planting. The film is available in clear or opaque stock of varying widths and thickness. Clear "poly", 1.5 mil thickness and 1.2 metres width, appears to be well suited to crop production in Manitoba.

"Poly" mini-tunnels are installed after planting and consist of clear-ventilated or shaded film stretched over wire hoops. The polyethylene used is generally 2.0 mil thickness and 1.5 metres in width. The wire is #9 gauge in lengths of 1.5 - 1.8 metres. Tunnel dimensions are 60 - 76 cm at the base and 45 - 50 cm in height.

The polyethylene mulch/mini-tunnel technique is a complex combination of the two and is considered impractical on a commercial scale.

With all techniques, the polyethylene is held in place by anchoring the edges with soil.

[1] Federal/Provincial funding

PLANTING, PLASTIC INSTALLATION AND REMOVAL

Transplanting or seeding precedes the installation of mini-tunnels. Therefore, conventional seeders or transplanters can be used. Similarly, seeding operations will precede the laying of polyethylene mulch. However, a transplanted crop requires the placement of the plants through the polyethylene film. In Manitoba, transplanting through the mulch is done entirely by hand, despite the availability of specialized planters which will efficiently perform this task. The cost of these units range from $2000 - $2500.

The laying of polyethylene mulch is entirely mechanized and once installed remains so for the entire growing season. The "mulch layer" mounts on a 3 point hitch and perfectly installs the "poly" film over a prepared soil bed. The units are commercially available at a cost of approximately $1300.

Mechanical installation of polyethylene mini-tunnels remains labor intensive. However, a Manitoba grower has pseudo-mechanized the installation of "poly" film over the supporting hoops. Tunnels are slowly opened and removed 3 to 4 weeks after installation.

Plastic mulch diggers and retrievers are available at a cost of $2400 - $4150. These units will lift the plastic and lay it loosely on the ground ready for pick-up and disposal. Unfortunately, the removal of "poly" mulch and mini-tunnels is still done entirely by hand in Manitoba. Continued extension efforts are required to promote the concept of mechanical removal.

SOIL AND AIR TEMPERATURE RESPONSE

In 1980 temperature readings were taken in the morning and afternoon on June 4 - 6, 16, 17. The mean soil temperatures at a depth of 5 - 7.6 cm under the clear "poly" films were significantly higher than those of the check or opaque films (Figure 4). Mean air temperatures within the mini-tunnel and mini-tunnel/mulch combination were noticeably enhanced. Undoubtedly, temperature enhancement was a key factor in the 1980 pepper yield and quality response.

SOIL MOISTURE

If soil moisture levels are not adequate, a thorough irrigation of the field is required a few days prior to mulch or mini-tunnel installation.

Generally, soil moisture was considered adequate for 3 - 4 weeks after "poly" installation and planting. At this time, tunnels were removed and/or the mulch slit to allow irrigation water or rainfall to replenish moisture reserves. Plastic mulch and the mini-tunnel/mulch combinations appeared to conserve soil moisture better than the tunnel technique.

In the U.S., trickle or drip irrigation is used with polyethylene mulch and tunnels. Manitoba Agriculture has been evaluating the benefits of trickle irrigation in commercial vegetable production for the past three years and a report is forthcoming.

WIND PROTECTION

Vegetable transplants and seedlings are extremely sensitive to wind. Vine crops can be stressed and show signs of "foliar burn" when exposed to only gentle breezes. Mini-tunnels protect the crop during the critical period of establishment. The exorbitant cost of hot-caps appears to favour the use of mini-tunnels.

WEED CONTROL

Opaque "poly" mulches prevent germination of many types of weeds or smothers them after they have germinated.

Weed growth under clear plastic mulch or mini-tunnels can be heavy. If possible, use of a pre-emergent herbicide is recommended.

PHOTO-DEGRADABLE PLASTIC MULCHES

The exposed portion of these plastics will slowly degrade with continued exposure to sunlight. It was hoped that this mulch would eliminate the costs and problems associated with removal and disposal.

Demonstrations of photo-degradable plastic mulch in Manitoba revealed that commercial application was impractical. Unfortunately, the soil covered edges of the plastic were very much intact following harvest. Long strands of plastic would have interfered with field operations in the fall and following spring. Furthermore, the cost of this film has been considerably higher than non-degradable polyethylene.

CROP RESPONSES

YIELD

In open fields, pepper, cucumber and watermelon yield response was generally positive to most of the plasticulture techniques (Figures 1, 2, 3).

With most crops and varieties, the yield response to the mini-tunnel/clear "poly" mulch combination technique was greatest. Unfortunately, the combination techniques are impractical on a commercial scale.

Excluding the combination techniques, green peppers responded very positively to the clear "poly" mulch and mini-tunnel techniques (Figure 1). Overall mean yield response of the varieties grown with the aid of mini-tunnels was 90% greater than check yields. This compared to a 74% yield improvement of the varieties grown on clear "poly" mulch.

In 1982, cucumber yield response to all the clear polyethylene techniques was very positive (Figure 3). Overall mean varietal yield increases for clear "poly" mulch were 89%, mini-tunnels 84.8%, and clear "poly" mulch/mini-tunnel combination 107.8%. However, in terms of practicality of installation the clear "poly" mulch and mini-tunnel techniques appear to be best suited for use in cucumber production. Mini-tunnels have the added benefit of providing wind protection during the establishment of transplants or seedlings.

Opaque plastics were not used with watermelons. Existing production data suggests that mini-tunnels or clear plastic mulch are best suited to watermelon production. An economic analysis of these techniques with watermelons has not been done.

In sheltered fields, the yield response to several of the plasticulture techniques was negative. In 1980 and 81, the mini-tunnel/clear plastic mulch combination technique gave the only positive yield response. The other techniques resulted in varietal yield reductions. An explanation of the yield variability among the "poly" techniques is likely very complex but probably linked, in part, to temperature stress.

MATURITY

The effect of plasticulture technology on crop maturity varies with annual climatic conditions. Generally, the various techniques can shorten the days to crop maturity as follows:

mini-tunnel + clear plastic mulch	=	7 - 11 days
clear plastic mulch	=	4 - 7 days
mini-tunnel	=	0 - 2 days
opaque plastic mulch	=	0 days

QUALITY

Green pepper market preference is for 3 - 4 lobed "bell-type" fruit. Elongated or "icicle-type" fruit are undesirable.

In 1980-81, the effect of the plasticulture techniques on green pepper fruit quality was monitored. Varieties grown with the poly-ethylene mini-tunnels and mini-tunnel/mulch combinations consistently produced 98 - 100% "bell-type" fruit whereas the "poly" mulch technique and conventionally (no "poly" used) planted varieties produced 10-75% "icicle-type" fruit. Misshapen fruit is a regular occurance from open field grown peppers and can create a marketing concern. The factors which are related to abnormal fruit development must be identified through further research.

VARIETAL

The 1980-82 Agro-Man and departmental projects suggest that pepper and cucumber yield response to the various plasticulture techniques may vary with variety (Figures 1, 3). Further investigation is required to determine which varieties respond best to recommended plasticulture techniques.

INSTALLATION COSTS

The 1984 costs of the clear "poly" mulch and mini-tunnel techniques are as follows:

Plastic Mulch = $740/ha
(cost includes plastic; labour - plastic installation and removal and hand planting; mulch layer - interest and depreciation; variable costs - tractor)

Mini-Tunnels = $1285/ha
(cost includes plastic; wire hoops; labour - plastic installation and removal; application equipment - interest and depreciation; variable costs - tractor)

Mini-tunnel/mulch combinations - not practical on a commercial scale.

Partial budget analyses indicate that the mini-tunnel and clear "poly" mulch techniques have the potential to enhance net returns in open field cucumber and green pepper production. An economic analysis of plasticulture with watermelon production will be conducted in the near future.

SUMMARY

The combination techniques require mechanical modifications and improvements to be considered practical on a commercial basis.

This study indicates that the clear "poly" mulch and mini-tunnel techniques are agronomicaly suited to green pepper and cucumber production. The use of mini-tunnels in green peppers will require a change in planting patterns from two to one row of plants per bed. Mini-tunnels will provide excellent wind protection to establishing transplants or seedlings.

Preliminary investigations suggest that the clear "poly" mulch and mini-tunnels enhance watermelon yields. However, an economic analysis of plasticulture technology with watermelons has not been done.

A thorough economic and agronomic investigation of each and every situation is necessary before a recommendation or decision is made to use plasticulture technology.

Since 1981, the Agro-Man program has been instrumental in the successful transfer of plasticulture technology to commercial vegetable production. In 1984, at least 12 hectares of vegetable crops were produced with the aid of clear polyethylene mulches or mini-tunnels in Manitoba.

ACKNOWLEDGEMENTS

The project would not have been possible without Agro-Man and departmental funding or without the co-operation of the following farms:

Berry Hill Farms, Altona
Itzke River Farm Ltd., Baie St. Paul
Jeffries Bros. Vegetable Growers, Portage la Prairie
Kroeker Farms Ltd., Winkler
Mayfair Farm, Portage la Prairie
Vanstone Wholesalers Nurseries, Portage la Prairie

Figure 1. GREEN PEPPER YIELD RESPONSE TO PLASTICULTURE - 1980
(in unsheltered field)

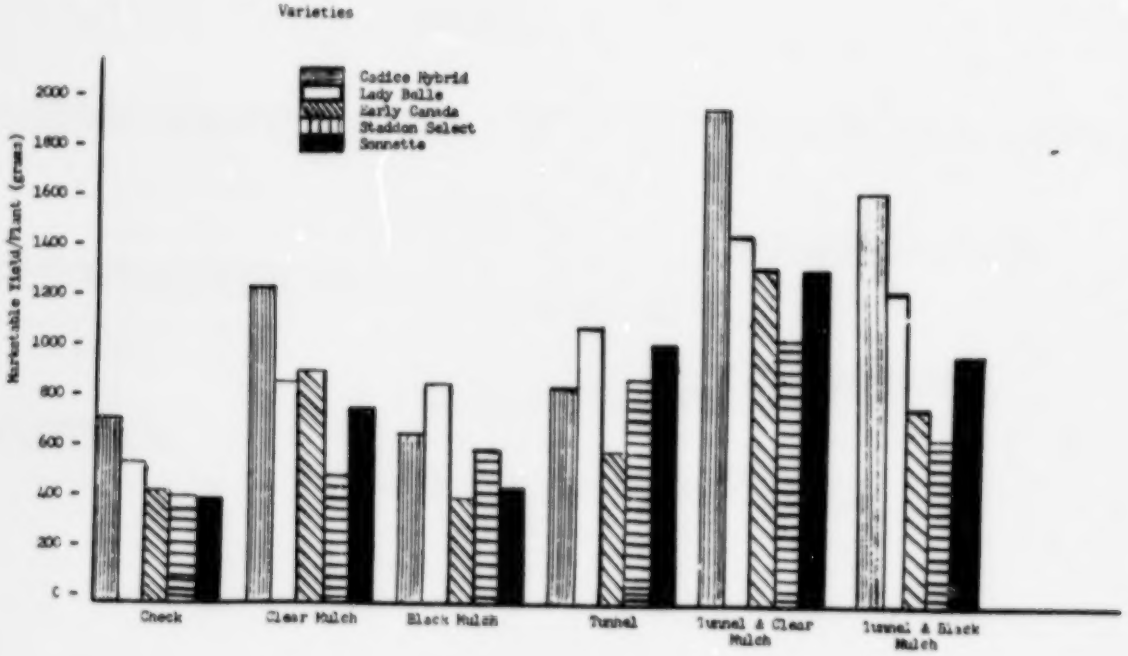


Figure 2: WATERMELON MARKETABLE YIELD RESPONSE TO PLASTICULTURE - 1982

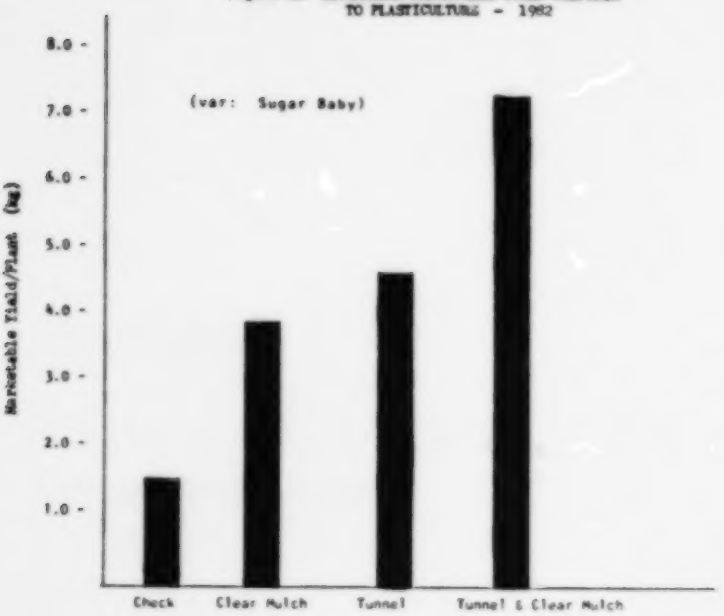


Figure 3: CUCUMBER YIELD RESPONSE TO PLASTICULTURE TECHNIQUES - 1982

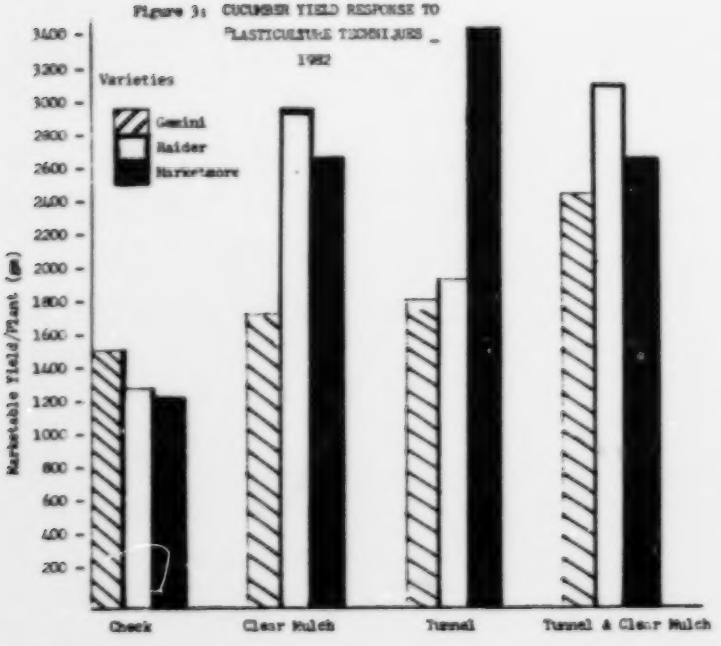
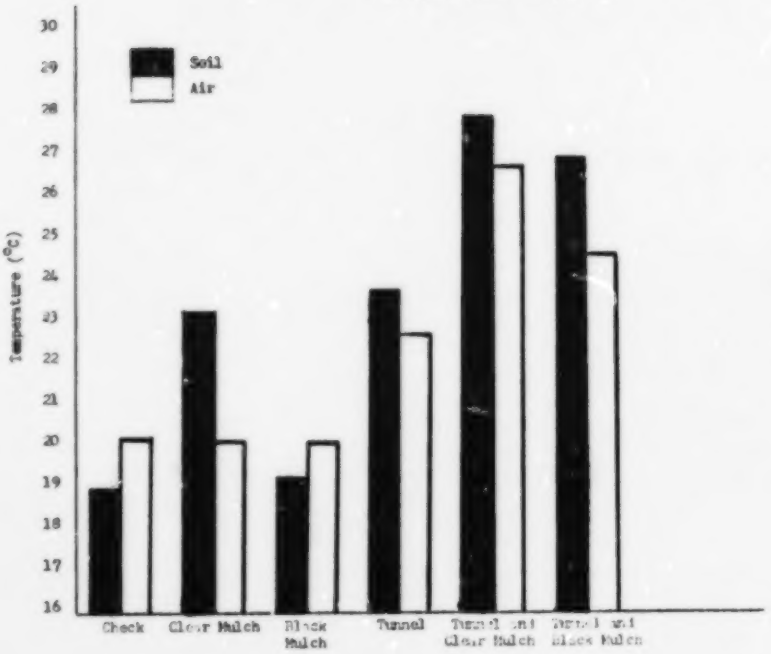


Figure 4: SOIL AND AIR TEMPERATURE RESPONSE TO "POLY" FILMS - 19[illegible]



The Effect of Soil Erosion on Soil Productivity: Preliminary Findings of a Two-year Study.

Rose Morrison Ives and C.F. Shaykewich.
Department of Soil Science, University of Manitoba

Soil erosion on the prairies is once more receiving attention. The recent Senate Standing Committee on Agriculture Report on Soil Degradation has brought the situation to the attention of the general public. In many parts of agricultural Manitoba, lower than average precipitation over the past two years, combined with less-than-soil-conserving farming practices, have caused spring dust storms reminiscent of times that many would rather forget.

Assessing the effect of soil erosion on soil productivity is not simple. Research conducted in the United States (Pierce et al, (1983) and Schertz (1983)). while perhaps providing general guidelines for Manitoban researchers, strongly indicates that erosion effects are modified not only by soil texture, but also by other properties of the solum, by cropping practices and, of course, by local climate. Occasional, isolated weather conditions, which can cause unusually severe erosional events, often have a more profound effect on soil productivity than can be estimated from a study of average climatic conditions.

MATERIALS AND METHODS

To compare within-site differences in crop yields under erosion conditions, it is necessary that the site should be level and the soil profile uniform. Since these conditions are seldom met in the field (an 'eroded' field often consists of dry, eroded knolls and moister depositional areas) it was decided to conduct a 'scalping' experiment. In this method, erosion is simulated by removing various portions of the Ah horizon.

Two experimental sites were established in May, 1983, one on a Reinland LVFS near Gladstone and the other on a Newdale CL (smooth phase) near Minnedosa. At both sites, the Ah horizon was about 20 cm thick.

The experiment was built on a randomized, complete block design; four levels of topsoil removal (0, 5, 10 and 20 cm) were replicated four times. Each soil removal treatment was split into three fertilizer treatments: a control, the recommended rate and a higher-than-recommended rate of fertilizer application. The objective was to see if extra fertilizer would have a mitigating effect where topsoil had been removed. Sites were seeded to Benito wheat at 100 kg/ha in late May.

In 1984, the two first-year sites were again seeded to Benito wheat, as well as a newly-established third site on a

degraded Pembina CL soil near Altamont. This year, 90 kg/ha N was included at all sites, in the highest fertilizer rate (Table 1).

Table 1. Fertilizer Rates and Seeding Dates.

	Seeding Date	Fertilizer Treatment A	B	C
Reinland LVFS				
	1983 May 21	0	20 kg/ha P_2O_5	45 kg/ha P_2O_5 30 kg/ha K_2O
	1984 May 10	0	10 kg/ha P_2O_5	90 kg/ha N 45 kg/ha P_2O_5
Newdale CL	1983 May 27	0	20 kg/ha P_2O_5	45 kg/ha P_2O_5
	1984 May 9	0	35 kg/ha P_2O_5	90 kg/ha N 45 kg/ha P_2O_5
Pembina CL	1984 May 11	15 kg/ha S	40 kg/ha N 10 kg/ha P_2O_5 15 kg/ha S	90 kg/ha N 45 kg/ha P_2O_5 30 kg/ha S

Data collected during the two growing seasons included soil temperature, soil moisture and precipitation. Midseason tissue samples were taken when the crop was headed and final grain samples were harvested from each subplot at crop maturity.

RESULTS

Wheat Yields a) 1983. On the Newdale CL there was a consistent decline in yield with each increase in the amount of topsoil removed, while on the Reinland LVFS , only the 20 cm soil removal treatment had a substantially lower yield. At both sites, only the 20 cm soil removal treatment had a significantly lower yield than the control.

b) 1984. Average wheat yields on the Reinland LVFS soil decreased with each increase in topsoil removal. Where 10 or 20 cm of topsoil had been removed, yields were significantly lower than the control. This year, this trend was not seen on the Newdale CL. There were no significant differences among wheat yields where 5, 10 or 20 cm of topsoil was removed, although these were significantly lower than the

average wheat yields obtained from control plots at P=0.1. On the Pembina CL soil, wheat yields between control plots and those where 5 or 10 cm of topsoil had been scalped were not significantly different, but average wheat yields from the deeply scraped plots (20 cm) were significantly depressed when compared to controls. (Table 2).

Table 2. Wheat Yield.

Site	Depth of Topsoil Removed	Wheat Yield (tonnes/ha)* 1983	1984
Reinland LVFS	0	1.603a	2.297a
	5	1.708a	1.911ab
	10	1.389a	1.551bc
	20	0.575b	1.073c
Newdale CL	0	2.768a	2.785a
	5	2.231a	2.306a
	10	2.040a	2.269a
	20	1.633b	2.263a
Pembina CL	0		2.986a
	5		3.043a
	10		2.876a
	20		1.498b

* Within location and year, means followed by the same letter are not significantly different at P = 0.05.

Effect of Fertilizer In the first year of this study, fertility treatments had no significant effect on yield at either site. On the LVFS, subplots that were fertilized to soil test recommendations yielded slightly less than those which received either no fertilizer, or the heavier fetilizer application. On the Newdale CL, the soil test recommendation treatment had the highest yield with the other two treatments slightly lower. In 1984, however, significant fertilizer effects were seen. At all three locations, grain yields (averaged over soil removal treatments) were significantly higher in the subplots that had received the heaviest fertilizer application (Table 3).

Crop Germination In 1983, wheat germination was uneven on the scraped plots of the Newdale soil. Although no significant germination differences were found at any of the sites in 1984, 'scalped' plots on the Newdale CL showed signs of tractor tire compaction well into the season, and in these places, crop growth was somewhat slow.

Growing Season Precipitation During both years of this study, growing season precipitation was below the long-term average for each area. Analysis of soil moisture data is

Table 3. Effect of Fertilizer Treatment on Grain Yield.

Site	Fertilizer Treatment	Grain Yield (tonnes/ha)* 1983	1984
Reinland LVFS	A	1.356a	1.481a
	B	1.253a	1.571a
	C	1.347a	2.072b
Newdale CL	A	2.065a	2.172a
	B	2.353a	2.231a
	C	2.087a	2.814b
Pembina CL	A		2.148a
	B		2.363a
	C		3.291b

* Within location and year, means followed by the same letter are not significantly different at P = 0.05.

not yet complete: some researchers (Frye et al. (1982)) have suggested that a decrease in available water-holding capacity was the most important yield-limiting effect in the eroded soils they investigated.

DISCUSSION

When topsoil is lost to erosion, soil organic matter is also lost. At all three field sites, in the top 15 cm of soil, the organic matter content of the most deeply scraped plots was less than fifty per cent of that found in the controls (Table 4). Since soil organic matter (by aiding aggregation and providing ground cover) helps protect soil from erosion, the decreased organic matter content of eroded soils can leave them more vulnerable to further erosion. On the loamy sand site, wheat yields on some of the 20 cm plots were so low that crop residues would be insufficient to protect this soil into the next crop year.

Table 4. Soil Organic Matter Content, Late Fall, 1984.

Depth of Topsoil Removed	Per cent Organic Matter in the Top 15 cm of Soil Reinland LVFS	Newdale CL	Pembina CL
0	2.5	6.7	2.9
5	1.7	3.0	2.3
10	1.5	3.4	1.8
20	1.1	3.3	1.0

It is worthwhile to note that, in 1984, at all sites, while fertilizer response was not always uniform in the control and 5 cm plots, on the 10 and 20 cm soil removal plots, the highest fertilizer application increased grain yields substantially. It is also noticeable that, in all

cases, the highest yields achieved on the 10 and 20 cm subplots did not equal the highest yields obtained from the control subplots (Table 5).

Table 5. Highest Grain Yields Obtained in 1984.

Site	Depth of Topsoil Removed	Fertilizer Treatment	Yield (tonne/ha)
Reinland			
LVFS	0	A	2.35
	5	C	2.05
	10	C	1.99
	20	C	1.95
Newdale			
CL	0	C	3.13
	5	C	2.58
	10	C	2.66
	20	C	2.89
Pembina			
CL	0	C	3.81
	5	B	3.20
	10	C	3.67
	20	C	2.55

This year, extra fertilizer improved yields on the more deeply 'scalped' plots, but not, it seems, to the original level of soil productivity. In 1983, wheat yields on the 10 and 20 cm plots remained low, despite extra fertilizer inputs.

Many site-years' data would be needed to fully evaluate the effect of soil erosion on a soil's productivity. Preliminary results of the present study indicate that soil erosion reduces crop yields, that extra inputs can often improve the productivity of eroded soils, and that, dependant on soil characteristics and management practices, the original (uneroded) productivity of the soil may not be completely regained.

REFERENCES

Frye, W.W., Ebelhar, S.A., Murdock, L.W. and Blevins, R.L. 1982. Soil erosion effects on properties and productivity of two Kentucky soils. Soil Sci. Soc. Am. J. 46: 1051-1055.

Pierce, F.J.,Larson, W.E., Dowdy, R.H. and Graham, W.A.P. 1983. Productivity of soils: assessing long-term changes due to erosion. J. Soil and Water Conserv. 38: 39-44.

Schertz, D.L. 1983. The basis for soil loss tolerances. J. Soil and Water Conserv. 38: 10-14.

N-P DUAL BANDING UPDATE

A.O. Ridley
Department of Soil Science, University of Manitoba

Placement of phosphorus for crops has received considerable attention at this conference in recent years. A thorough review of methods of P placement was presented by Racz in 1980. This was followed in 1981 by a paper on dual N-P banding by Toews, in which data from some trials conducted in the 1981 season were discussed. This paper presents a brief review, but focuses on recent research information on dual banding of N and P fertilizers.

Deep banding of nitrogen has been widely practised since the introduction of anhydrous ammonia. Since crop response to ammonia nitrogen applied in bands 10-15 cm below the surface was often better than other nitrogen fertilizers, part of the benefit was attributed to the deep placement. With the introduction of pneumatic seeders it became possible by combining the air system with a heavy duty cultivator, to deep band (10-15 cm below the surface) dry pelleted N fertilizer such as urea and ammonium nitrate. Nitrogen solutions were also deep banded behind heavy duty cultivators, but using pumps rather than air to propel the fertilizer.

With the success of deep banding nitrogen, deep banding of P was also considered as an alternative to seed placed or broadcast P. Subsequently dual banding of N and P became of interest.

Phosphorus Fertilizer in Soil

Monoammonium phosphate and ammonium polyphosphate (dry and liquid fertilizer respectively) are the main phosphate supplying fertilizers used in Manitoba. Both are highly water soluble and available to crops. Recovery by crops in the year of application, however, is quite low and varies with type of crop (Strong and Soper 1974a and b) and soil properties. In general, plant uptake is 18-35% of the P applied but may be much lower for some crops including flax. Bailey et al. (1980) in a review of P fertilizer placement and uptake by crops state that "plants vary considerably in the development of their root systems, both because of species and the conditions of the rooting environment". This would have an effect on P recovery. In the soil, P fertilizer can react with calcium and magnesium, forming reaction products with lower solubilities. The P is thereby immobilized and remains close to the position of original placement. Placement of P fertilizer for maximum uptake of P and crop yields is therefore an important consideration in fertilizer management, and has prompted interest in deep band N P application.

Effect of Dual Banding of N and P

In this technique, N and P fertilizer is placed 10-15 cm below the surface using a heavy duty cultivator to open the furrows. Spacing between bands varies with the make of the cultivator but bands are generally 15-45 cm. apart. It is important that these bands are not disturbed by subsequent cultivation as this results in mixing of soil and fertilizer, and renders the fertilizer P no more effective than broadcast and incorporated P.

Field experimentation with deep band placement of N and P was initiated in Manitoba in recent years. (Toews (1982) in a trial conducted on a Snowflake C.L. soil at Purvis found that N (as urea) banded together with P (as MAP) and applied in the fall produced significantly greater yields than the control (Table 1). Phosphorus banded with the seed also increased yields, but to a slightly lesser extent. On a Stockton S. at Neepawa (Table 2) yields of barley were also increased by the application of P with the seed; P deep banded with N; and split application of P (i.e. 1/3 P with seed, 2/3 P deep banded with N). Highest yield was obtained from dual deep banding of N and P. Similar experiments were conducted in 1982 and 1983 on an Altona L. at Carman (Rogalsky and Ridley, 1984). Data in Table 3 again shows yield response to all methods of P application, however P with seed produced the highest yield in 1982; and split application of P produced the highest yield in 1983.

These recent results from Manitoba are in agreement with data presented by Racz (1980). A summary of that data is shown in Table 4 and indicates a crop yield response to P with largest yield increases due to P applied with the seed or deep banded (7-10 cm) in narrow spacing.

Harapiak et al (1982) conducted 23 trials under dryland conditions in western Saskatchewan and the south half of Alberta during 1980-81 to assess the placement effect of P on yields of wheat and barley. Data in Table 5 shows a greater response to P with seed when N was banded rather than broadcast. This may be due to placement of N in the root zone in areas where precipitation was not adequate to move surface broadcast N into the soil. Response to dual deep band N and P was equal to that of deep band N with seed placed P. Data also shows a definite benefit to some P placed with the seed when dual banding N and P.

Results of field scale trials using commercial equipment, conducted by Hultgreen and Morgan (1984) in Saskatchewan are shown in Table 6. In these trials wheat was grown on stubble land and a good response to both N and P was obtained. Phosphorus was equally effective when placed with the seed (N banded) or when dual banded with the N. The broadcast N treatment with P placed with the seed was considerably lower in yield than the treatment of banded N with seed placed P indicating that broadcast N was not being effectively used by the crop.

Effect of Moisture Stress

Trials conducted by Harapiak et al (1982) over much of the western prairies has shown that moisture stress can affect response to N P placement (Table 7). Data from the trials reported in Table 6 was arranged according to water stress. The data showed that when moisture stress is low, response to P is less affected by placement. Lowest response however occurred when P was broadcast. Under moisture stress, largest yields were obtained when N and P was dual banded or when N was deep banded and P was placed with the seed. It is also evident that particularly under dry conditions broadcasting N and/or P gives the lowest yield response.

Effect of Additional Seed Placed P on P Response

Ukrainetz (1984) studied the effect of deep banded P with additional seed placed P on yields of wheat on fallow in northwestern Saskatchewan. Data in Table 8 shows that the additional seed placed P resulted in larger yields than when all P was deep banded, except for one fall treatment on Whitewood loam. These results are generally consistent with data reported previously. Banding of fertilizer in the spring produced greater yields than fall banding, and indicates that on fallow land, deep tillage in the spring may not be harmful to seedbed preparation and stored moisture.

Effect of Time of Dual Banding of N and P

Racz (1980) presented data from six trials conducted with wheat in 1979 and 1980, comparing spring with fall applied P (N was applied after planting)/ Results were: spring banded P 2861 kg/ha; fall applied P 2688 kg/ha; no phosphorus 2338 kg/ha. Highest yields were thus obtained with spring banding. Placement of P in these experiments was relatively shallow (7-10 cm) and may not have caused excessive soil disturbance. Band spacings were also narrow (17.5 cm).

Harapiak (1982) summarized data comparing spring-fall applied N and P trials conducted on the western Prairies. The rating for fall applied N+P band treatment relative to the same treatment applied in the spring was 94%, indicating greater effectiveness of spring dual banding.

Not all data however, shows spring dual banding as being superior to fall dual banding. Data by Toews in Table 1 shows results to be equal.

One facet of deep banding of fertilizers that is of concern to agronomists is the effect of deep tillage on seedbed condition and moisture storage. While results reported favor deep banding in spring, data for this comparison is not extensive. Deep tillage in spring could result in loose lumpy seedbeds and loss of stored soil moisture in some years. A detrimental effect of deep band operation when conducted in spring is shown in data by Ukrainetz (Table 9). Deep band operation alone (1348 kg/ha) reduced yield compared to no fertilizer treatment (1511) by 163 kg/ha.

Effect of Band Spacing

Ukrainetz (1984) states that "deep band spacing for P is even more important than for N". Data from northwestern Saskatchewan (Table 9) shows that narrow spacings gave the best results in four experiments conducted in N.W. Saskatchewan. These results are in agreement with data from Manitoba. Flaten and Racz (1984) showed that wheat yields in a trial at Carman were highest when N P bands were 18 cm apart as compared to 36 cm (Table 10). Rogalsky and Ridley (1984) however, report variable results. In two trials conducted with barley at Carman, highest yields were obtained when N P was dual banded at 40 cm in the fall compared to 20 cm wide bands. Results with flax were the reverse, and 20 cm wide bands produced the highest yields.

The width of spacing of the fertilizer bands directly affects the proximity of the fertilizer to the roots of newly germinating seeds. Since plants require P early in their growth stage, narrow rows theoretically should be superior. Narrower row spacings however, automatically reduces the concentration of fertilizer in the bands if application rate is consistent. Lower concentrations result in more soil-fertilizer contact which could reduce availability to plants. Variable results are therefore not surprising. Another factor also enters into the effect of concentrations of N P in dual bands and this is related to NH_3 toxicity resulting from urea.

Effect of Urea N in Dual N-P Bands

When urea N is applied to soil, free NH_3 may be evolved. This could have an inhibiting effect on plant root exploitation of P when urea N, and P are dual banded. Indication that this may occur is shown by data of Flaten and Racz in Table 10. In this data, separate bands of N and P produced larger yields than dual bands. The N source in this experiment was urea.

Results from growth chamber studies with wheat by Flaten and Racz (1984) support the urea effect on plant growth. They found that when urea was banded with MAP near the seedrow P uptake from the bands was delayed 7 to 10 days. They attributed this slow uptake to high levels of NH_3 in the fertilizer band that prevented roots from entering the band. After 10 days P uptake was rapid, presumably because of reduced NH_3 concentration and there was no difference in yield at final harvest compared to bands placed away from the seed. Ukrainetz (1984) comments with respect to data shown in Table 8 "as the rates of banded ammonium N increase, it is important that all or some of the P fertilizer be applied with the seed". This would compensate for delayed P uptake from the dual N P bands where urea was the N source.

Effect of Solution Fertilizers and NH_3

Nitrogen and phosphorus solutions are used in Manitoba, separately applied and in combination. Research comparing dual N P banding of solutions with dry product, however, have not been conducted in Manitoba, to the author's knowledge. Some data from research in North Dakota is reported by Dahnke and Swenson (1982). They showed that deep banding of solution N+P produced a large increase in yield of barley and smaller increases in yield of flax and mustard (Table 11). Deep banding was superior to broadcast N and P only, with barley. Research in Nebraska by Penas, reported by Dahnke and Swenson (1982), showed that good yield increases were obtained with solution P applied with the seed (NH_3 banded); banded separately from NH_3; or dual banded with NH_3. Highest yield was obtained with dual banding, and broadcasting of P was not effective.

Dual banding of NH_3 and P solution for wheat was also found to be superior to banding of NH_3 and seed placed P by Houlton in Montana, reported by Racz (1980). In this study fertilizer was applied prior to seeding. Any detrimental effect of NH_3 on availability of P is not evident (Table 13)

Results thus show that solution fertilizers applied in dual bands can be as effective as dry product.

Banding of N and P for Canola and Flax

Bailey et al (1980) and Racz (1980) have extensively reviewed placement of P for canola, flax and other crops. In general they reported that placing P with or near the seed at rates tolerable to the seed was more effective than broadcast P. For crops that did not tolerate seed placed P, sidebanding close beside or below the seed was preferable. Experiments however did not include deep dual or separate banding of N and P. In 1982, 1983 and 1984 field trials were conducted by the Department of Soil Science, University of Manitoba to investigate the effect of deep banding N and P on yields of flax and canola. Results of this research have been disappointing due to general lack of response to P in 1982 and 1983 and the severe drought conditions in 1984.

Banding of N and P for Winter Wheat

Interest in the production of winter wheat is increasing on the cold Prairies, including Manitoba. To avoid winter kill the crop must be protected by an insulating layer of snow. Zero till planting is thus recommended to retain standing stubble and trap snow. This places constraints on banding of fertilizer other than at time of seeding because of the likelihood of stubble disruption. Rourke et al (1983) conducted field experiments at Portage La Prairie and Minto in 1982 to compare the effect of seed placed P (N deep banded) with dual N P bands on yield of winter wheat. Results are shown in Table 14. At Portage La Prairie results are variable but show a response to N+P. On the average, dual banding (3292 kg/ha) was slightly more effective than seed placed P with N banded (3000 kg/ha). At Minto there was also a response to N+P but virtually no difference between P with the seed and dual banded.

Summary and Conclusions

1. Dual banding of N and P appears to be a good alternative method of fertilizer application to placing all P in the seedrow and applying N separately.

2. For maximum yields some P should be placed with the seed and the remainder can be deep dual banded with N.

3. When high rates of urea or ammonia N are dual banded with P, some P should be placed with the seed to provide early P uptake until the free ammonia in the band has dispersed. This is particularly of concern for spring banding.

4. When moisture stress is low (soils moist) response to P may be less affected by placement, i.e. dual deep banding and P placed with seed may have similar effect. Under moisture stress deep dual banding may have an advantage over all P placed with the seed.

5. Data generally indicates that spring banding is more effective than fall banding of N and P. However deep working of soil in spring can produce a poor seed bed and moisture loss in some years.

6. Narrow bands (15-20 cm) are generally more effective than wider bands (30-45 cm). This effect may vary with type of crop and moisture stress.

7. Solution N and P are equally effective as dry product when dual banded.

8. Dual banding of N and P for oilseeds is inconclusive.

9. Any tillage conducted after deep banding should be shallow. If bands are disrupted, results will be no better than broadcast fertilizer.

10. Dual banding of N and P can be an effective method of applying fertilizer for winter wheat, however it may be necessary to apply it at time of seeding.

References

Bailey, L.D., Ukrainetz, H., and Walker, D.R. 1980. Effect of phosphorus placement on crop uptake and yield. Proc. The Western Canada Phosphate Symposium. Calgary, Alberta. 200-229.

Dahnke, W.C., and Swenson, L.J. 1982. N-P placement. Proc. Manitoba Soc. Soil Sci., Winnipeg, Man. 173-178.

Flaten, D. and Racz, G.J. 1984. Dual banding studies using labelled M.A.P. Proc. Manitoba Soc. Soil Sci., Winnipeg, Man. 173-180.

Harapiak, J.T., Flore, N.A. and Timmermans, J.G. 1982. Deep banding of N-P fertilizers: Some conclusions and recommendations. Proc. Saskatchewan Soils and Crops Workshop, Saskatoon, Sask.

Hultgreen, G.E., and Morgan, R.E. 1984. Fertilizer banding results, 1981-83. Proc. Saskatchewan Soils and Crops Workshop, Saskatoon, Sask. 51-54.

Racz, G.J. 1980. Method and time of phosphorus application for annual crops. Proc. Manitoba Agronomists Conf., Winnipeg, Man. 154-169.

Rogalsky, E.J. and Ridley, A.O. 1983. Fertilizer placement for maximum yields of barley, flax and rapeseed. Proc. Manitoba Soc. Soil Sci. 108-112.

Rourke, R.D.S., Grant, C.A., and Stobbe, E.H. 1983. Fertilizer management practices for winter wheat. Proc. Manitoba Agronomists Conf. Winnipeg, Man. 94-107.

Strong, W.M. and Soper, R.J. 1974 a. Phosphorus utilization by flax, wheat, rape and buckwheat from a band or pellet-like application. I. Reaction zone root proliferation. Agron. J. 65:597-600.

Toews, W.H. 1981. Dual N-P banding. Proc. Manitoba Agronomists Conf. Winnipeg, Man. 127-132.

Toews, W.H. 1982. A field evaluation of dual deep placed nitrogen and phosphorus on four Manitoba soils using barley, flaxseed and rapeseed as test crops. Proc. Manitoba Soc. Soil Sci., Winnipeg, Man. 179-186.

Ukrainetz, H. 1984. Fertilizer placement for maximum effectiveness. Proc. Optimum Tillage Workshop, Saskatoon, Sask.

Table 1. Effect of time and method of N and P application on yields of barley at Purves. (1981)

Method of application	Time of application	Yield (kg/ha)
N only banded	fall	2426
N banded; P with seed	fall	2815
N + P banded together	fall	2936
N + P banded together	spring	2920

N @ 66 kg/ha using urea
P_2O_5 @ 42 kg/ha using MAP
Bands @ 40 cm
Data by: Toews (1982) University of Manitoba

Table 2. Effect of method of P placement on barley yields at Neepawa (1981).

Method of application	Yield (kg/ha)
N only banded	2214
N banded; P with seed	2554
N + P banded together	2687
N banded with 2/3 of P, 1/3 P with seed	2647
N + P banded together (A.N. nitrogen)	2727

N @ 100 kg/ha using urea except on treatment #5 A.N.
P_2O_5 @ 50 kg/ha using MAP
Bands 40 cm
All treatments spring applied
Data by: Toews (1982) University of Manitoba

Table 3. Effect of dual banding N and P fertilizer on yields of barley.

Treatment	Grain Yield (kg/ha)	
	1982	1983
N only banded	3668	2732
N banded; P with seed	4399	3294
N and P banded together	4279	3149
N banded with 2/3 of P 1/3 with seed	4284	3513

N @ 100 kg/ha using urea
P @ 22 kg P/ha using MAP
Bands @ 40 cm
All banding in fall
Data by: Rogalsky and Ridley (1984) University of Manitoba

Table 4. Effect of method of phosphorus application on yield of wheat.

Method of placement	Yield (kg/ha)
No P	2338
P with seed	2818
P broadcast and incorporated	2658
P deep banded	2861

P_2O_5 at an average of 2 rates, 25 and 50 kg P_2O_5/ha at each site.
Four sites in 1979. Two sites in 1980.
P_2O_5 applied as T.S.P. in spring prior to planting.
Row spacings 17.5 cm.
Data from: Racz (1980) University of Manitoba

Table 5. Response of cereals to P as influenced by methods of placement in dryland trials.

Treatment	Yield (kg/ha)	Response to P (kg/ha)
Control	1700	
N broadcast	2180	
N banded	2340	
N broadcast +	2350	170
N banded +	2600	260
N+P broadcast	2290	110
N+P banded	2590	250
N+P broadcast +	2510	330
N+P banded +	2660	320

+ indicates some P applied with seed.
Data from Harapiak et al (1982)

Table 6. Effect of N and P placement on yields of wheat in field scale trials.

Treatment	Yield of wheat (kg/ha)
Banded N; seed placed P	1918
Banded N + 100% of P	1911
Banded N + 75% of P 25% of P with seed	1838
Banded 75% of N; seed placed P	1821
Broadcast N; seed placed P	1649
No N; seed placed P	1272
No fertilizer	981

N @ 56 kg/ha as urea
P @ 28 kg/ha as MAP
Total of 16 sites on previously cropped land during 1981-83 in Watrous area of Saskatchewan
Data from: Hultgreen and Morgan (1984).

Table 7. Deep banding benefit on dryland trials as related to growing season moisture conditions.

Fertilizer treatment	Yield (kg/ha)	
	Favorable[1] moisture	Moisture[2] stressed
N broadcast, P with seed	2820	1520
N deep banded, P with seed	2930	1960
N and P broadcast	2690	1560
N and P dual deep banded	2860	2090
Unfertilized control	2100	940

[1] 14 trials
[2] 9 trials
Data from: Harapiak et al (1982)

Table 8. Response of wheat and barley to banded and additional seed placed phosphate fertilizer.

Treatment	Grain Yield (kg/ha)		
	Site 1	Site 2	Site 3
DB 20 P Fall	-	1742	2744
Spring	2496	1870	3255
DB 20 P Fall + 10 P with seed	-	1877	3074
Spring + 10 P with seed	2604	2367	4197
DB 40 N + 20 P Fall	-	1742	3383
Spring	2227	1836	2966
DB 40 N + 20 P Fall + 10 P with seed	-	1856	2980
Spring + 10 P with seed	2744	2051	3820
20 P with seed	2803	1789	3202
Control	2351	1695	2731

Site 1: barley on Scott loam 1981
Site 2: wheat on Waseca loam 1984
Site 3: wheat on Whitewood loam 1984
Band spacing 30 cm
N as urea; P as MAP
Data from: Ukrainetz (1984)

Table 9. Effect of deep band spacing on response of wheat and barley to P fertilizer applied in the spring.

Treatment	Band Spacing	Yield (kg/ha)
Deep band P only	15	1910
	30	1778
	45	1480
Deep band P+N	15	1906
	30	1668
	45	1677
P with seed		1775
No fertilizer		1511
Deep band operation only		1348

P @ 20 kg/ha; N @ 40 kg/ha. Data from: Ukrainetz (1984)

Table 10. Effect of N-P placement on yields of wheat.

Treatment	Yield (kg/ha)
No P	2617
P with the seed	3169
Separate banded P, preplant @ 36 cm spacing	3032
Dual N-P band @ 18 cm	2983
Dual N-P band @ 36 cm	2833

Data from: Flaten and Racz (1984) University of Manitoba

Table 11. Yield of crops as influenced by deep band and broadcast application of solution N and P.

Rate and placement	Yields (kg/ha)		
	Flax	Barley	Mustard
Control	1070	2360	350
N + P deep banded	1130	3660	580
N + P broadcast	1190	3120	540

N @ 67 kg/ha using 28-0-0
P_2O_5 @ 38 kg/ha using 10-34-0
Data from: Dahnke et al. North Dakota.

Table 12. Influence of placement of solution phosphorus fertilizer on yield of wheat.

Fertilizer source and placement	Yield (kg/ha)
NH_3 only	2020
10-34-0 broaccast + NH_3	2080
10-34-0 with seed + NH_3	2350
10-34-0 knifed + NH_3 (separate)	2550
10-34-0 knifed + NH_3 (together)	2820

N @ 67 kg/ha
P_2O_5 @ 28 kg/ha
Data from: Penas, Nebraska.

Table 13. Yield of wheat as affected by N and P placement.

Rate of application (kg/ha)		Yield (kg/ha)			
		Crop on fallow		Crop on stubble	
N	P_2O_5	Separate	Dual	Separate	Dual
0	0	1196	-	477	-
19	66	1404	1606	696	941
64	66	1452	1868	870	1233
86	66	1492	1841	985	1196
109	66	1532	1801	1099	1200
120	66	1458	1801	1081	1159

N source: 82-0-0
P source: 10-34-0
Fertilizer applied prior to seeding
Data by: H.A.R. Houlten, Montana

Table 14. Effect of N P placement on yield of winter wheat at Portage La Prairie and Minto.

Method of placement		Yield (kg/ha)	
N	P	Portage La Prairie	Minto
Banded @ 20 cm	dual band	3645	3643
Banded @ 20 cm	with seed	2444	3797
Banded @ 30 cm	dual band	3248	-
Banded @ 30 cm	with seed	2924	-
Banded @ 40 cm	dual band	2984	3582
Banded @ 40 cm	with seed	3634	3532
Broadcast (spring)	with seed	2798	3688
None	with seed	2419	1958
No fertilizer		2349	1485

P_2O_5 @ 40 kg/ha using MAP
N @ 70 kg/ha using A.N. at Portage La Prairie and urea at Minto
Data by: Rourke et al (1983)

EUROPEAN CORN BORER INFESTATION - 1984

A.J. Kolach
Extension Entomologist, Manitoba Agriculture

The European corn borer has been present in Manitoba since 1948. It has been a pest of the sweet corn industry in years of abundance. Control measures in sweet corn were known to have been applied in 1955, 1963 and 1982. In 1983 and 1984 the most severe corn borer infestations ever recorded occurred in sweet, grain and silage corn.

Corn acreage in Manitoba has increased significantly in recent years. No doubt increased acreage and continuous cropping have been factors, along with other favorable conditions such as weather, for the severe infestations of corn borer which have occurred in 1983 and 1984.

In 1983 the corn borer was present in virtually every corn field in Manitoba. Infestations ranged from 50 - 100% in all fields surveyed. Infestation levels of 1 - 3 corn borer per plant were common in most areas, with levels of 20+ corn borer per stalk common in the Morden and Plum Coulee areas. Corn yield losses were significant in 1983 in the severely infested areas which included Altona, Morden, Plum Coulee and Carman.

In 1984 the infestation occurred over the entire corn growing area, but had become more severe in the Eastern region, notably the Beausejour district and also in the McGregor area than in 1983. Severe infestations again occurred in the Altona, Morden and Carman districts.

The corn borer overwinters in Manitoba, however, significant overwintering mortality can occur in some years if extreme fluctuations of temperature occur. There is one generation of corn borer in Manitoba, however in some years as much as 5 - 15% of the population attempts a second generation. It is believed that the second generation is unable to complete its development due to the short growing season. Although the corn borer does overwinter, it is not known how much of the population responsible for yield losses migrates in from the United States.

The corn borer overwinters as a fully developed larvae in corn stubble and refuse stalks. It is a cold hardy insect and generally overwinters well. The larvae pupate in June and begin emerging as moths by mid to late June. Peak moth flights occur in July. In 1983 peak moth flights occurred around July 8 and again about August 27 at Glenlea, the latter not considered to be significant as far as control measures are concerned. Peak flights in 1984 in light traps at Altona, Carman, McGregor and East Selkirk began around July 10 in southern Manitoba and were somewhat later in the central areas. Light trap monitoring has been useful in predicting egg laying and timing for control measures.

Eggs are layed on undersides of corn leaves and appear as white, scalelike masses, each containing from 5 - 50 eggs. In about a week, larvae emerge and begin feeding openly on the leaves, boring into the stalk in about 5 days. It is at this point of open feeding that chemical control is effective. Once inside the stalk, the corn borer is impossible to control. Damage to corn occurs in two main ways, ie. stalk breakage due to tunnelling within the stalk and direct yield loss of cob and kernel development. One borer per stalk can reduce cob and kernel yield by 3%. Similar losses to sweet corn could also be applied, however, there is an additional loss in marketability and price due to presence only of the borer in or on the cob.

Corn growers in 1983 were caught completely by surprise, and only two grain corn fields were known to have been sprayed. In 1984 most growers in the severely infested areas were prepared and undertook control measures. Most followed recommendations, however some growers used unregistered insecticides. Manitoba Department of Agriculture personnel assessed the effectiveness of the various controls used by growers in 1984. Assessments were made by checking 10 corn plants at random for breakage, and splitting 2 for borer counts at each of 5 locations in each field starting at one corner and working towards the centre. The confidence of this technique was verified by doing a more indepth assessment of checking 10 plants at 10 locations and dissecting every plant. The results of each were much the same and the quicker method was then used to allow for more assessments.

Furadan F treatments applied by air with either 7.5 or 15 litre water coverage between July 18 and August 4 were effective in consistently reducing corn borer numbers. One treatment with Furadan F consistently reduced numbers to an average of 3 corn borer per stalk, two treatments consistently reduced numbers to an average of 1 per stalk. Furadan 10G applied by air in the whorl was not as effective as Furadan F. This may have been due to the lateness of the granular applications. Furadan CR-10 was ineffective, although there were some application problems. Carbaryl XLR was effective in one field, but not in 2 others, therefore inconsistent. However, only 3 fields in total treated with carbaryl XLR were assessed. Lorsban 4E, although unregistered gave excellent control in the one field that was assessed. In fields that were not treated with insecticides, corn borers numbered between 5.3 - 20.5 with an average of 10.4 per stalk. The highest numbers of corn borer per stalk were found in the Morden area, which was exactly the same situation as in 1983.

Two applications of Furadan F provided the best control of corn borer of all treatments assessed. However, the extra cost of a second treatment would have been justifiable only if better than average yields were obtained and if corn prices were high.

The losses in yield in 1984 due to corn borer in the severely infested areas in fields which were not treated for control ranged from 16 - 62%. This does not take into account further losses due to stalk breakage, as it is impossible to determine how much of the broken corn can still be harvested. The results of assessments are given in Tables I and II.

There is certainly a potential for another severe outbreak of corn borer in 1985, however this will depend on favorable weather conditions for its survival and development this winter and spring and early summer of 1985.

TABLE I EFFECTIVENESS OF REGISTERED INSECTICIDES FOR CORN BORER CONTROL IN 1984

TREATMENTS	AVERAGE STALK BREAKAGE	AVERAGE # BORERS/PLANT
Furadan F (1) aerial, 1 application	24.7	2.9
Furadan F (6) aerial, 2 applications	12.3	1.1
Carbaryl XLR aerial, 3 applications	50.0	7.8
Untreated (8)	65.8	10.4

(#) Number of fields assessed

TABLE II EFFECTIVENESS OF UNREGISTERED INSECTICIDES FOR CORN BORER CONTROL IN 1984

TREATMENTS	AVERAGE STALK BREAKAGE	AVERAGE # BORERS/PLANT
Furadan CR-10 (2) (ground)	84.0	12.2
Furadan 10G (3) (air)	29.3	5.7
Lorsban 4E (1) (air)	12.0	2.4
Untreated (8)	65.8	10.4

(#) Number of fields assessed

REFERENCES

1. Hanec, Wm. and Kolach, A.J. 1964. Proceedings of the Entomological Society of Manitoba 20: 7-11.

2. North Central Regional Publication #22. 1983. Management of the European Corn Borer. Iowa State University.

MANITOBA GRASSHOPPER FORECAST - 1985

D. L. SMITH, MANITOBA AGRICULTURE

The Manitoba grasshopper forecast, prepared from surveys carried out by Manitoba Agriculture, indicates that the area and severity of grasshopper infestations expected in 1985 will be at least two and one half times greater than that experienced in 1984. The forecast area of infestation covers over 15,500 km^2, with 10,260 km^2 rated as light, 4680 km^2 rated as moderate and 610 km^2 in the severe category. The greatest increase in area and severity is forecast for western and central Manitoba.

In western Manitoba the infestation extends from Inglis south to the United States border and southeast through Miniota and Oak Lake to Boissevain. A severe area of infestation is located between Hartney and Pipestone extending south to Medora. A large moderate area of infestation extends southwest from Pipestone to the Saskatchewan border and from Medora south to the United States border. Smaller areas of moderate infestation occur west of Miniota, south of Oak Lake and east of Whitewater Lake.

In central Manitoba, a very large area of light to moderate infestation lies approximately between Neepawa, Brandon and Wawanesa on the west, extending to Fannystelle and Roland on the east.

In the Red River Valley, areas of light infestation occur between Kane and Brunkild extending east to Glenlea and between Otterbourne and Dufrost, east of the Red River.

In western and central Manitoba, the clear-winged grasshopper is the dominant species, occurring on pastures, roadsides and hayland. In the Red River Valley, the two striped grasshopper is dominant, occurring along headlands, roadsides and drainage ditches.

The forecast is intended only to provide a general indication of where grasshopper infestations will occur in 1985, and at what level. Under hot, dry conditions, infestations will be more severe than forecast and economic infestations may occur outside the forecast area. Cool, wet weather, favorable for crop development, will lessen the impact of grasshoppers.

THE 1984 SUNFLOWER MIDGE SURVEY

D. JAY McCULLOUGH, MANITOBA AGRICULTURE

This is the third year in which the Manitoba Department of Agriculture has carried out a survey for the sunflower midge. The survey is carried out in cooperation with extension personnel from North Dakota. It is based on the following rating scheme:

None - no midge present

Light - ray flower involved, bracts showing browning, little effect on florets, no economic damage

Moderate - cupping of heads in edge rows and into the field

Severe - cupping of heads throughout the field

The infested area has remained fairly static since 1983. It is bounded by the escarpment west of Morden and approximately by #1 highway in the north and in the east by a line running south from Ste. Anne.

The intensity of the infestation is lower than it was in 1983, with the moderate and severe categories noticeably reduced. Most of the Red River Valley fell into the light category with a small northwestward movement into the Starbuck and Elie areas. Importantly, however, all the fields in the new area either had no midge or fell into the light category. Light infestations are noneconomic. The survey was extended somewhat west this year to slightly beyond the escarpment to determine if the infestation had expanded out of the Red River Valley. We found no midge in fields more than a couple of kilometers west of Morden.

Since there were insufficient fields in the Emerson-Altona area to do a survey, we have assumed that the area would fall into the light category. Data collected by extension people in North Dakota appear to support this assumption.

A total of 106 fields were surveyed and placed in one of the three categories listed in the first paragraph. The following table shows the percentage which fell into each of these categories.

CATEGORY	PERCENT OF TOTAL FIELDS
None	37
Light	53
Moderate	10
Severe	0

It is very possible the levels now being experienced are similar to those in existence prior to 1982.